(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL.

OCTOBER, 1905.

CONTENTS.

	PAGE
Locomotives, Common Standard—Harriman Lines (Boilers)	353*
Enormous Traffic in Cities	356
Foreign Railroad Practice, Impressions of—G. M. Basford	357
Railroad Equipment in the United States	357
Advice to Draftsmen	357
Steel Car Equipment, Pennsylvania Railroad	358*
Injector Strainers and Suction Pipes	359
Railroad Shop Forces, Organization of—H. T. Bentley	360
Freight Locomotive, 4—6—0 Type, Rock Island System	362*
Blacksmith Shop, Canadian Pacific Railway, Montreal	363*
Locomotive Boilers, Hydrostatic Tests of	365
The Foreman's Place	365
Third Rail for New York Central	366*
Electric Power for Shops, Selection of	366
Freight Locomotives, Mikado Type, Northern Pacific Ry	367*
Locomotive Tests with 250-lbs. Pressure	368
Forging and Repairing Locomotive Motion Rods	369*
Master Mechanics Letter Ballot, Result of	369
Mr. George M. Basford	370
The Machine Tool Builder and His Tools	370
Water Purification	370
Improved Shop Methods	371
Reporting Locomotive Defects	371
An Undeserved Slur	371
Draftsmen	371
Production Improvements, L. S. & M. S. Ry	372*
Automatic Door Opener	372
Water Purification, Results of	373
Why Steel Can Be Cut Faster Than Iron	373
Passenger Car Repair Shop	374*
Dies and Formers for Bulldozers	375
Water Tube Locomotive Boiler	376*
1906 M. M. and M. C. B. Conventions	376
Power Plant, Operation of the McKees Rocks Shops	377
Vacations	377
Electric Traveling Hoists	378*
Steam Turbine, Starting a	379
Landis Bolt Cutter Head and Chasers	380*
Planer Type Milling Machine with Auxiliary Vertical Spindle	381*
Shearing Strength of Rivets	381*
Universal Forging Machine	382*
Steel Frame Multipolar Motors	383*
Wm. Sellers as a Designer of Machinery	383
Removing Splinters	383
Inspection Locomotive, New York Central Lines	384*
Traverse Grinder	384*
Manufacturing Plant of the B. F. Sturtevant Company	385*
Car Journal Lubricator	386*
Why Driving Axles Should Be Bored	386
Milling Machine Efficiency	386
Books and Personals	387
Catalogs and Business Notes	388

*ILLUSTRATED ARTICLES.

COMMON STANDARD LOCOMOTIVES.

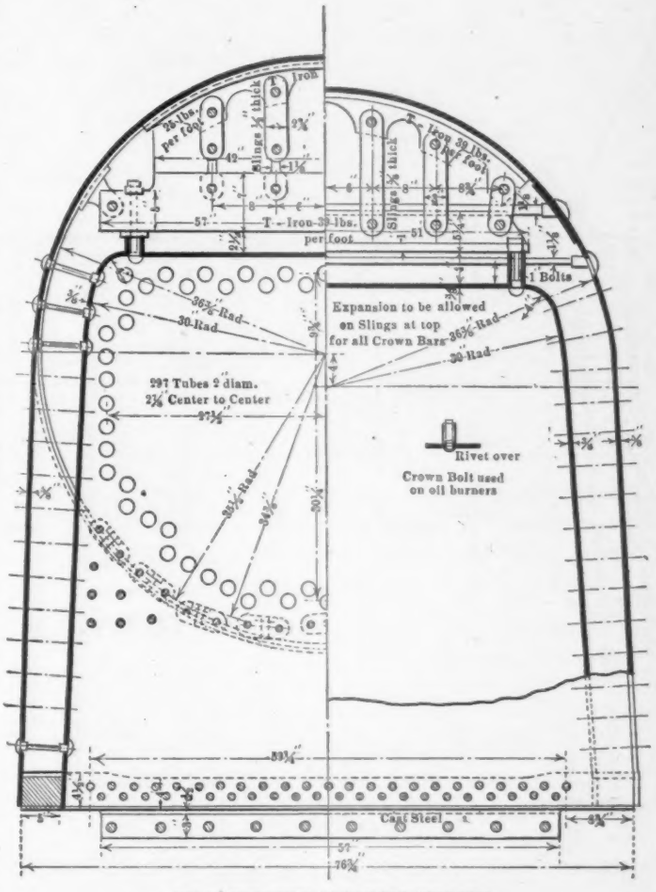
HARRIMAN LINES.

VI.

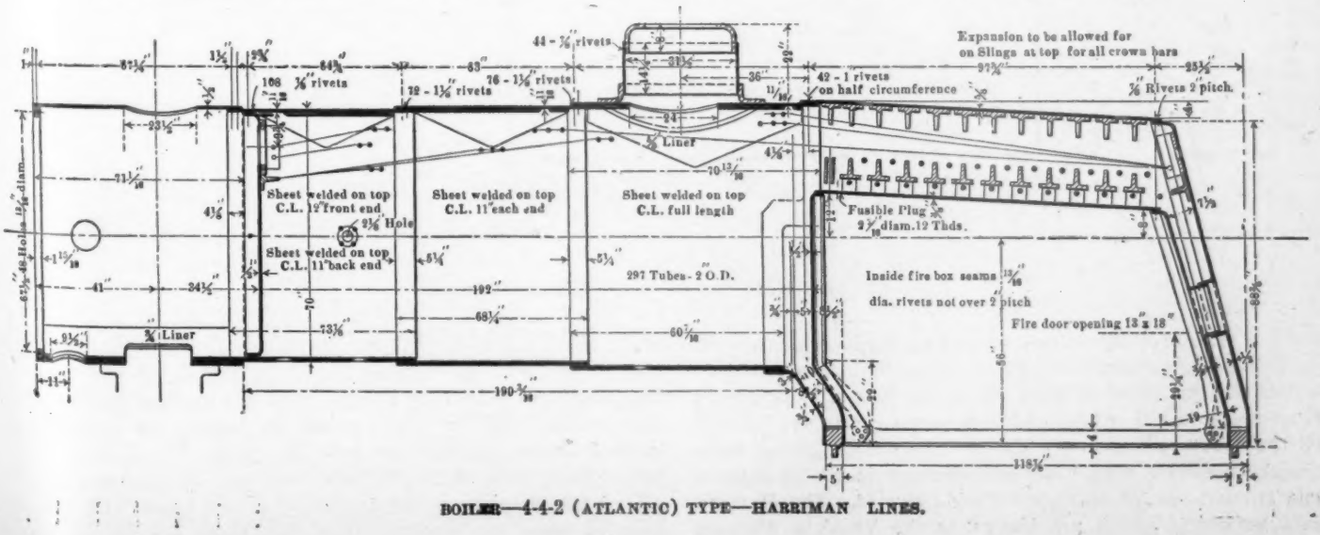
(*For previous articles see pages* 154, 200, 250, 288 *and* 322.)

The general dimensions of the boilers were given in the table in the May number of this journal, page 154, which indicates that there are but two sizes of boiler barrels, all of which are 70 ins. in diameter outside of the first ring, except the boilers of the consolidation locomotives, which are 80 ins. in diameter. The three designs of the road engines have the same size firebox, viz., 108 ins. long by 66 ins. wide. All have the same grates and the same grate casting was applied in all with somewhat different shaking rigging for the different types. An important item in this boiler construction is a water space of 5 ins. all around the fireboxes of the road engines. The water spaces for the switcher firebox are 4 ins. in front and 3½ ins. at the sides and back.

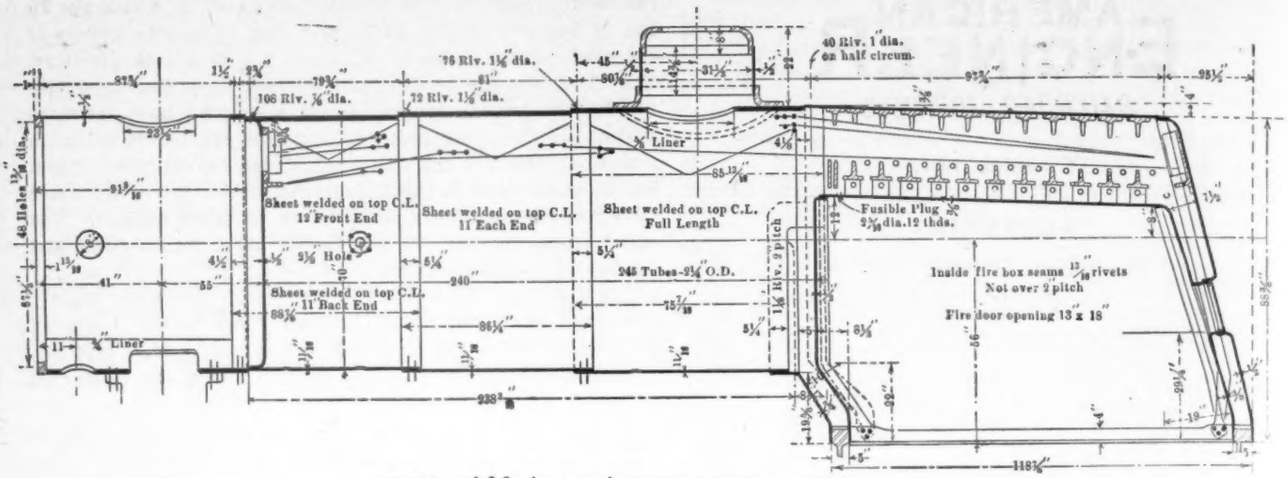
The fireboxes of the Atlantic and Pacific types are exactly alike, the chief differences between these boilers being in the length. All of the mud rings are of cast steel, 5 by 4 ins. in section and reinforced at the corners. They are all double


Iron
Slings ⅝ thick
T - Iron 39 lbs. per foot
Bolts
Expansion to be allowed on Slings at top for all Crown Bars
36⅜" Rad.
30 Rad.
297 Tubes 2 diam. 2¼ Center to Center
Rivet over Crown Bolt used on oil burners
Cast Steel

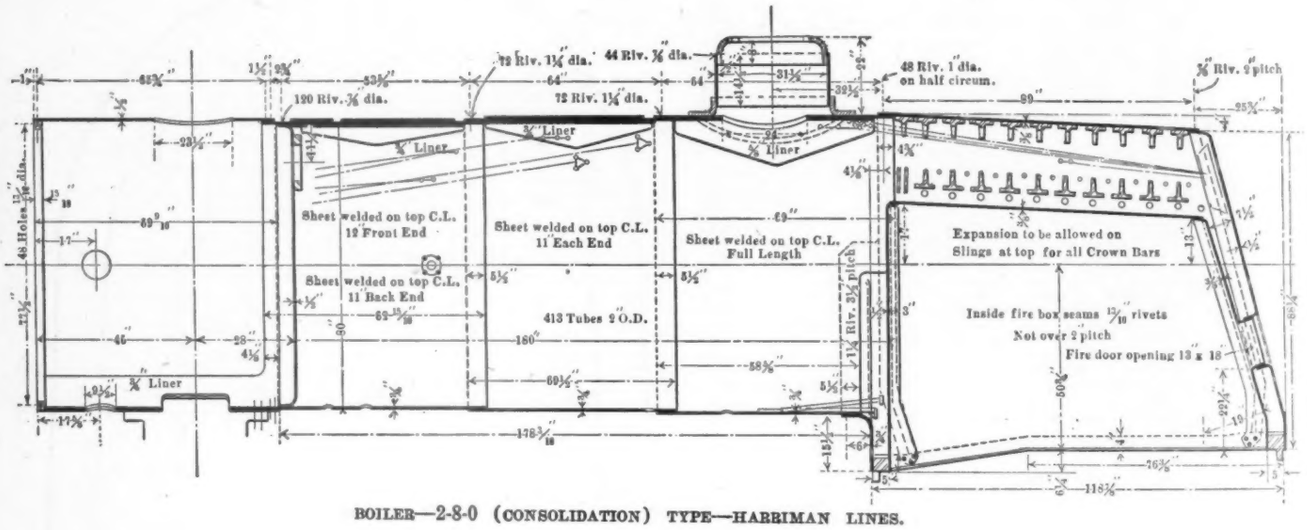
CROSS-SECTIONS THROUGH FIREBOX.


44 - ⅞ rivets
Expansion to be allowed for on Slings at top for all crown bars
42 - 1 rivets on half circumference
⅝ Rivets 2 pitch.
⅝ Liner
Sheet welded on top C.L. 12" front end
Sheet welded on top C.L. 11" each end
Sheet welded on top C.L. full length
Sheet welded on top C.L. 11" back end
¾ Hole
Fusible Plug 2" diam. 12 Thds.
297 Tubes - 2 O.D.
Inside fire box seams ⅝ dia. rivets not over 2 pitch
Fire door opening 13" x 18"
¾ Liner

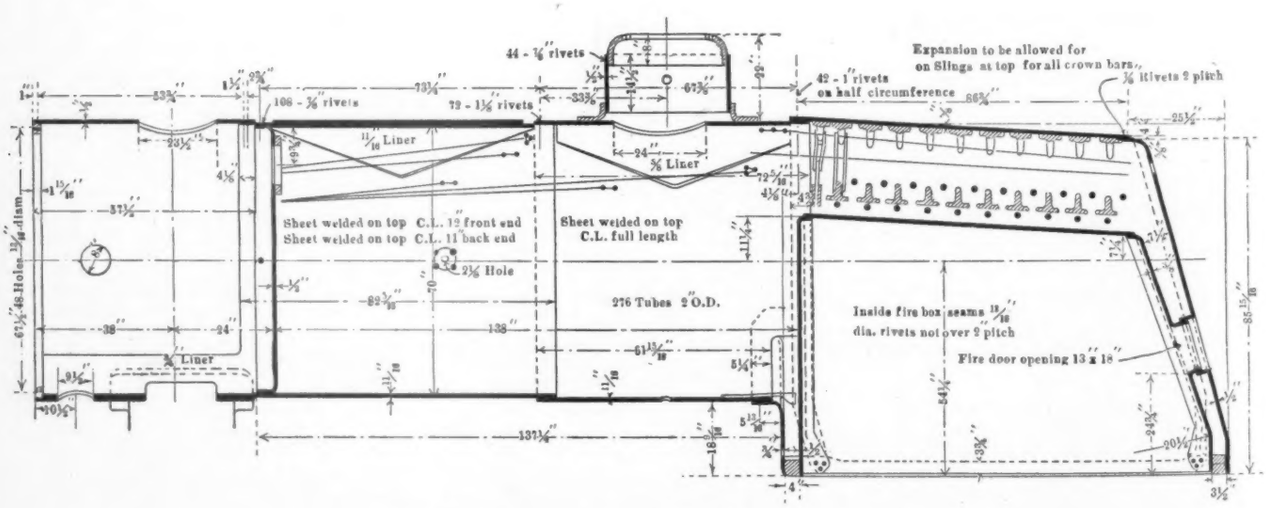
BOILER—4-4-2 (ATLANTIC) TYPE—HARRIMAN LINES.


76 Riv. 1⅛" dia.
40 Riv. 1" dia. on half circum.
106 Riv. ⅞" dia.
72 Riv. 1⅛" dia.
⅜" Liner
Sheet welded on top C.L. 12 Front End
Sheet welded on top C.L. 11 Each End
Sheet welded on top C.L. Full Length
Sheet welded on top C.L. 11 Back End
Fusible Plug ⅝ 2⅜ dia. 12 thds.
245 Tubes-2¼" O.D.
Inside fire box seams 12/16 rivets Not over 2" pitch
Fire door opening 13" x 18"
48 Holes 13/16 dia.
⅝" Liner
1185/16"

BOILER—4-6-2 (PACIFIC) TYPE—HARRIMAN LINES.

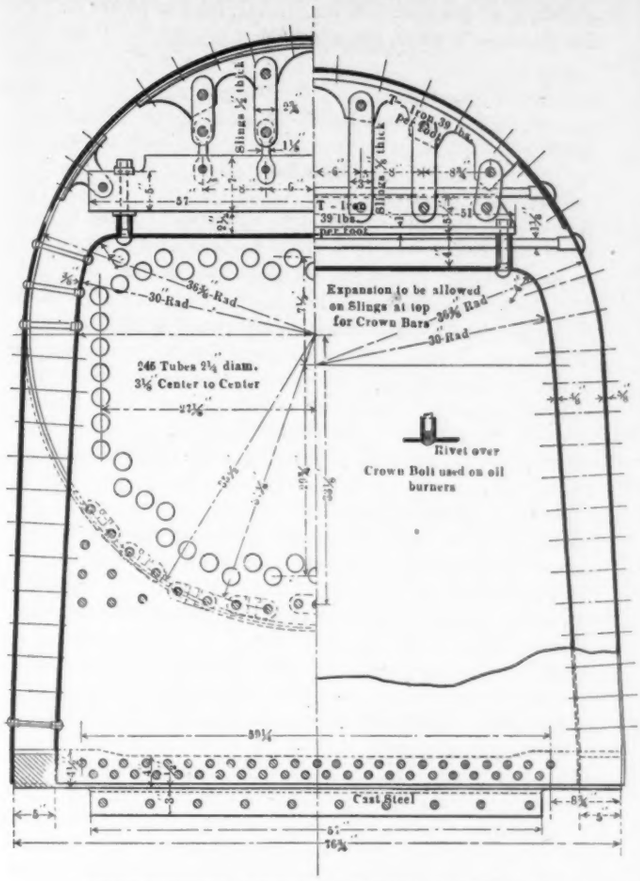

72 Riv. 1¼" dia.
44 Riv. ⅞" dia.
48 Riv. 1" dia. on half circum.
⅜" Riv. 2" pitch
120 Riv. ⅞" dia.
72 Riv. 1¼" dia.
⅜" Liner
Sheet welded on top C.L. 12 Front End
Sheet welded on top C.L. 11 Each End
Sheet welded on top C.L. Full Length
Sheet welded on top C.L. 11 Back End
413 Tubes 2" O.D.
Expansion to be allowed on Slings at top for all Crown Bars
Inside fire box seams 12/16 rivets Not over 2" pitch
Fire door opening 13" x 18"
48 Holes 13/16 dia.
⅝" Liner
1183/16"

BOILER—2-8-0 (CONSOLIDATION) TYPE—HARRIMAN LINES.

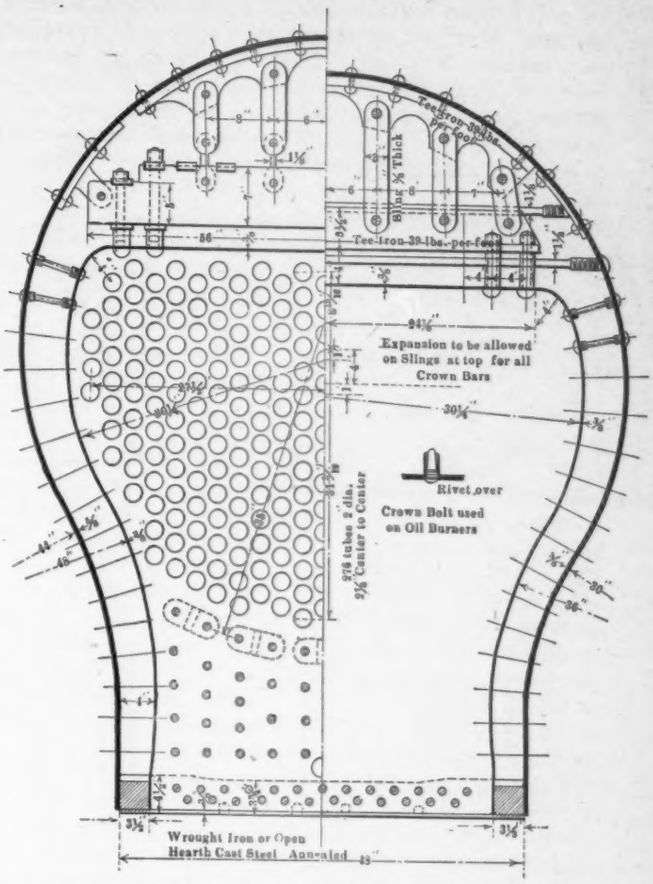

44 - ⅞" rivets
Expansion to be allowed for on Slings at top for all crown bars
42 - 1" rivets on half circumference
⅜" Rivets 2 pitch
108 - ⅞" rivets
72 - 1⅛" rivets
11/16" Liner
⅜" Liner
Sheet welded on top C.L. 12 front end
Sheet welded on top C.L. 11 back end
Sheet welded on top C.L. full length
2⅛" Hole
276 Tubes 2" O.D.
Inside fire box seams 12/16" dia. rivets not over 2" pitch
Fire door opening 13" x 18"
48 Holes 13/16" diam.
⅜" Liner
1371/4"

BOILER—SWITCHING LOCOMOTIVES—HARRIMAN LINES.

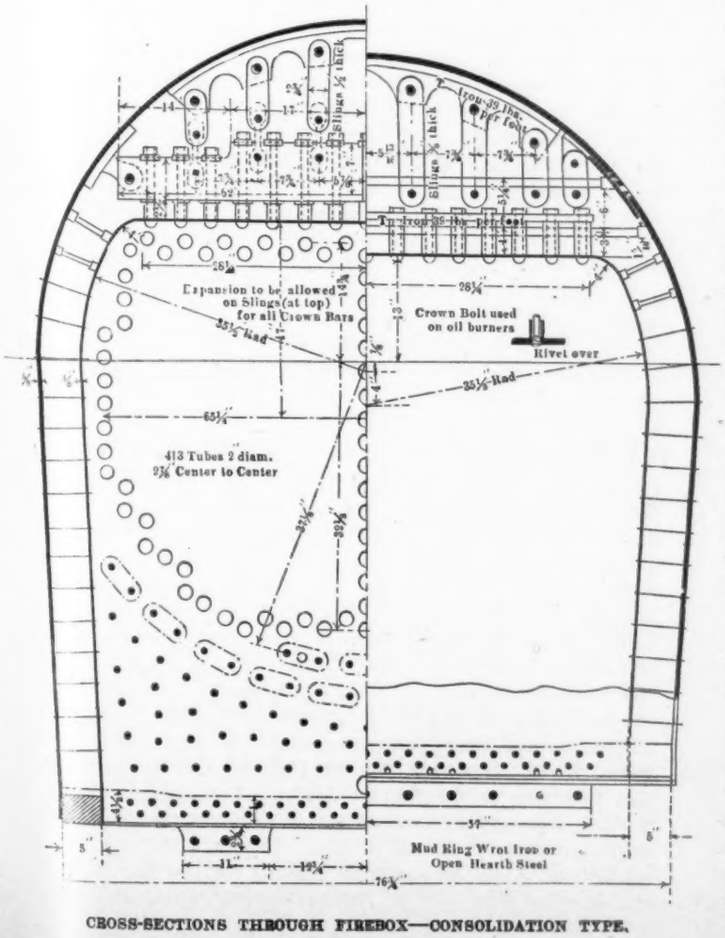
riveted. In all of the boilers the crown sheets are supported by T iron crown bars attached by slings to T iron roof bars which are continuous through the crown; that is to say, there is no break in the center. All the crown sheets are flat and all the boilers are straight top, except as the fireboxes slope towards the rear. The sheets are telescopic in all the designs. The circumferential seams are double riveted. The diamond welt horizontal seams are known as the Vauclain diamond boiler seam, which has an efficiency of 96 per cent. The dome ring is welded at the top and has no outside welt. The very long seams are welded for a length of 11 ins. at each end. The tube spacing provides ⅞-in. bridges, the tubes being arranged in vertical rows. The Pacific type has 2¼-in. flues because of their length, 20 ft., while the others are of 2 ins. in diameter. All of the boilers are fitted with 8-in. dry pipes with the Rushton open top throttle. The side stays are ⅞ in. in


Slings ½ thick
T-Iron-39 lbs. Per Foot
Slings ⅝ thick
Tee-Iron 39 lbs. per foot
30 Rad
36⅝ Rad
Expansion to be allowed on Slings at top for Crown Bars
246 Tubes 2¼ diam. 3⅛ Center to Center
Rivet over Crown Bolt used on oil burners
Cast Steel

CROSS-SECTIONS THROUGH FIREBOX—PACIFIC TYPE.


Tee-Iron-39 lbs. per foot
Slings ⅝ Thick
Tee-Iron-38 lbs. per foot
Expansion to be allowed on Slings at top for all Crown Bars
Rivet over Crown Bolt used on Oil Burners
270 tubes 2 dia. 2⅝ Center to Center
Wrought Iron or Open Hearth Cast Steel Annealed

CROSS-SECTIONS THROUGH FIREBOX—SWITCH ENGINES.


Slings ½ thick
T-Iron-39 lbs. Per Foot
Slings ⅝ thick
Tee-Iron-38 lbs. per foot
Expansion to be allowed on Slings (at top) for all Crown Bars
35⅛ Rad
Crown Bolt used on oil burners
Rivet over
413 Tubes 2 diam. 2⅛ Center to Center
Mud Ring Wrot Iron or Open Hearth Steel

CROSS-SECTIONS THROUGH FIREBOX—CONSOLIDATION TYPE.

diameter with 3-16-in. holes drilled 1¼ ins. deep in the outside ends only.

All the 70-in. boilers have 13-16-in. shell plates, and all the fireboxes have the same sheets. These boilers are all fitted with the Bates fire door, which is standard on the Southern Pacific Railway. All of the back heads are flanged to an angle of 15 degs. from the vertical, including the switcher.

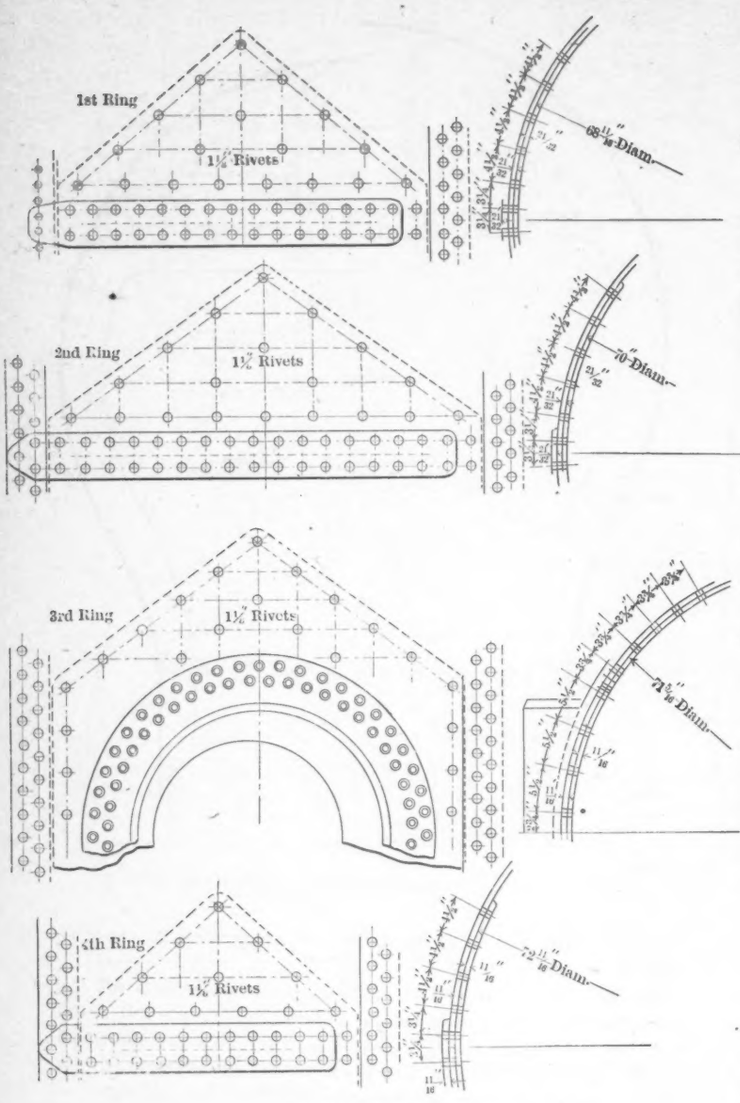
The switcher boiler is the only one with a narrow firebox. Its length is 108 ins. and its width 40¼ ins. This boiler has the same method of crown support, the same fire door and bridging of tubes as the other boilers. Except the switcher, which carries 180 lbs. steam pressure, all the boilers are built for 200 lbs. with a seam factor of five.

This set of standard boilers has been designed with unusual care in order to reduce to a minimum the amount of work in the boiler shop.

For information, drawings and permission to publish this description we are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines and to the Baldwin Locomotive Works. To the Baldwin Locomotive Works we are also indebted for the following description of the Vauclain diamond boiler seam which has been used by them for several years:

DIAMOND BOILER SEAM.—The accompanying engraving illustrates this seam as applied to the first, second, third and fourth rings, these joints having been designed for a working pressure of 220 lbs.

A well designed multiple riveted boiler joint would usually fail by tearing the plate along the outside row of rivets. It is, therefore, evident that the most efficient joint is the one that has a minimum amount of metal removed from this section, and at the same time has a sufficient number of rivets in the welt to prevent their shearing. This is the principle of the diamond seam, and because of its high efficiency it allows a considerable decrease in weight without greatly increasing the cost.



DIAMOND BOILER SEAM.

The calculations for the efficiency of this joint are the same as for any other multiple joint; like them it can fail by shearing the rivets, tearing the plates, crushing the rivets or plate or riveted joints; the bearing pressure per square inch is so small that the last method need not be considered.

To determine the efficiency it is necessary to calculate the strength of each line of riveting separately and compare it with the strength of the solid plate.

Considering the joint for the first ring we have:

46 ins. wide (rivet to rivet).

21-32 in. thickness of plate and welts.

1⅛ ins. diameter of rivets.

55,000 lbs., tensile strength of steel.

36,093 lbs., tensile strength of strip of plate 1 in. wide.

Through the first line of riveting the plate is weakened by the cross section of one rivet hole.

Therefore the net strength of this section is:

(46 ins. — 1⅛ ins.) x 36,093 = 1,623,272 lbs.

Strength of solid plate:

(46 ins. x 36,093) = 1,660,278 lbs.

$$\text{Efficiency,} = \frac{1,623,272}{1,660,278 \text{ lbs.}} = 97.7\%$$

The second line of riveting is weakened by the removal of metal for two rivets, but in order to fail here the rivet in the first line must shear.

Therefore net strength of this section is:

Strength of plate = (46 ins. — 2¼ ins.) x 36,093 = 1,579,068

Single sheet 1 rivet .994 x 40,000 = 39,760

Total, 1,618,828

$$\text{Efficiency,} = \frac{1,618,828}{1,660,278} = 97.4\%$$

Third line of rivets:

3 holes 1⅛ ins. dia. = 3¾ ins. net area of metal removed. Reinforced by 3 rivets in 1st and 2d row in single shear. Strength of plate = (46 ins. — 3¾ ins.) x 36,093 = 1,538,463

3 rivets 1⅛ ins. dia. single shear = 3 x 994 x 40,000 = 119,280

Total 1,657,743

$$\text{Efficiency,} = \frac{1,657,743}{1,660,278} = 99.8\%$$

Fourth line of rivets:

4 holes, 1⅛ ins. dia. = 4½ ins. net area of metal removed. Strength of net area of plate = (46 — 4½) x 36,093 = 1,497,860

6 rivets 1⅛ ins. dia. in single shear 6 x .994 x 40,000 = 238,560

Total 1,726,420

Efficiency slight excess over solid plate.

Fifth line of rivets:

8 holes 1⅛ ins. dia. = 9 ins. net area of metal removed. Strength of net area of plate = (46 — 9) x 36,093 = 1,263,255

10 rivets 1⅛ ins. dia. in single shear = 10 x .994 x 40,000 = 397,600

Total 1,660,855

Efficiency—slight excess over solid plate.

Sixth line of rivets:

The seam fails at this point by shearing the rivets between the outside welt and plate and by tearing the inside welt between the rivet holes.

15 holes 1⅛ ins. dia. = 16⅞ ins. net area of metal removed. Strength of net area of plate = (46 — 16⅞) x 36,093 = 1,051,208

14½ rivets, 1⅛ ins. dia. in single shear = 576,600

Total 1,627,808

$$\text{Efficiency,} = \frac{1,627,808}{1,660,278} = 98\%$$

Therefore, this particular design of seam has a minimum efficiency of 97.4%.

ENORMOUS TRAFFIC IN CITIES.—In New York, with its population of 3,750,000, there are being carried now on the surface, elevated and subway systems paying passengers, exclusive of so-called transfers, 1,200,000,000 per annum, a number very much greater than the number of passengers on all the steam railroads of both the American continents from the Atlantic to the Pacific, and from that most northern of all railroads, the Wild Goose Railway, near Nome, Alaska, within the Arctic Circle, to the most southern one in South America, the State Trunk Line, of Chili. London, with its population of over 6,000,000, but with inferior intra-urban railway facilities, carries about the same number as New York; while Paris, Berlin, Hamburg, Boston, Chicago and St. Louis are fast following in the leaders' tracks. Such figures need no further comment or explanation to indicate the dimensions of the problems of transit in great cities, and the difficulty of properly meeting the continual demand for increase in facilities as cities grow.—*W. B. Parsons, before Purdue students.*

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

NAPLES.

After a visit to England, France, Germany and Switzerland, and making as careful a study of railroad conditions as time permitted, we find ourselves in Naples, ready for the return voyage, after a most delightful tour. As no one in Italy appears to work, the time spent here was devoted entirely to enjoyment of the wonderful attractions with which this most interesting country abounds.

I cannot avoid a few general observations, the first of which is to point out the value of knowing by personal contact the conditions under which transportation has been conducted for many years abroad. One may visit Europe with a preconceived opinion that nothing is to be learned which will be of any value for application at home. However, by looking under the surface of English and Continental railroad practice a great deal is to be learned, and the impression soon grows into a conviction that American methods can be materially improved by engrafting some principles from Europe.

Of these principles, the one which I most earnestly desire to see adopted at home is the attitude of all, not only the railway officials, but the public, towards the locomotive and the men who are responsible for it, and for its use. Until we learn at home that the locomotive earns every dollar brought into the treasury, and until we learn that the men responsible for the locomotive and its work are really entitled to the high standing given to motive power officials abroad, and until we make the life of a motive power officer worth living, we have more to learn from England and the Continent than England and the Continent have to learn from us. If American railroad presidents should go where I went and meet the men I met they would return prepared to perform the best service for their stockholders that they have ever performed. This would not be by copying anything they saw abroad, but by acquiring appreciation of the possibilities to be had from putting the American locomotive and American motive power men upon their rightful and needful basis. This will be done some day, not for sentimental, but for purely business reasons.

Little remains unsaid as to the value of a tour out of one's own country. The mere getting on board of a magnificent steamer, the observation of the working of the ship, watching the continuous operation of the machinery for ten days without an "engine failure," the very certainty of navigation and its mathematical accuracy convey impressions of the worthiness of men. We purposely chose a slow steamer. On approaching the English coast at four o'clock in the afternoon the first officer promised that we should see the Scilly Island light on the port bow at 7:30 o'clock that evening. After nine days of by no means good weather the light appeared at 7:45, and it was on the port bow. This tells a story of years of development of ships, of machinery and of men.

It does no harm for one living in a new country to see that which is really old, and here in Italy we see it. It gives at first a strange impression to gaze on the bronze doors of the Baptistry in Florence, knowing that these doors were hanging there just as they are now when Columbus made his voyage. The conscientious thoroughness of the past centuries is also worth a thought. A snapshot picture of the Roman Forum, taken from an electric street car brings a reflection as to how our work will look when uncovered perhaps a couple of thousand years hence. This thought is most impressive in Pompeii, where all life was suddenly arrested in the midst of its activity, and is now revealed in all its detail.

I wonder if Raphael could possibly have dreamed that the Sistine Madonna, painted for an altar-piece for an obscure chapel, would become an object of pilgrimage. I wonder if he ever dreamed that that work of his hands and heart would cause a hush in a room in Dresden, and that people from an undiscovered country would derive an inspiration from it, which would perhaps affect in some degree their whole lives. Raphael died at the age of thirty-two. What inspired him and what enabled him to work so well?

A snapshot of the Cloaca Maxima where it empties into the Tiber shows an arch of stone, which for over 2,000 years has performed the duty of draining Rome, and performs that duty to-day. It tells a story of something thoroughly done for the benefit of future generations, which leaves an indelible impression upon one's mind. It is good to have seen these things, and their moral need not be pointed here.

I must now bring these letters to a close after the best and most inspiring trip that two people ever took. I can never express the grateful appreciation of the token so generously extended by the friends who made it possible.

G. M. BASFORD.

RAILROAD EQUIPMENT IN THE UNITED STATES.

On June 30, 1904, according to the Interstate Commerce Commission, there were in the service of the railways 46,743 locomotives, the increase being 2,872. As classified, these locomotives were: Passenger, 11,252; freight, 27,029; switching, 7,610. There were also 852 not assigned to any class.

The total number of cars of all classes was 1,798,561, this total having increased 45,172 during the year. The assignment of this rolling stock was, to the passenger service, 39,752 cars; to the freight service, 1,692,194 cars; the remaining 66,615 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 220, showing an increase of 6. The average number of cars per 1,000 miles of line was 8,474, showing a decrease of 66 as compared with the previous year. The number of passenger-miles per passenger locomotive was 1,948,384, showing a decrease of 30,402 miles. The number of ton-miles per freight locomotive was 6,456,846, showing a decrease of 351,096 miles as compared with June 30, 1903.

The aggregate number of locomotives and cars in the service of the railways was 1,845,304. Of this number 1,554,772 were fitted with train brakes, indicating an increase during the year of 92,513, and 1,823,030 were fitted with automatic couplers, indicating an increase of 52,472. Practically all locomotives and cars in passenger service had train brakes, and of the 11,252 locomotives in that service 11,113 were fitted with automatic couplers. Only 602 cars in passenger service were without automatic couplers. With respect to freight equipment, it appears that most of the freight locomotives had train brakes and automatic couplers. Of 1,692,194 cars in freight service on June 30, 1904, 1,434,386 had train brakes, and 1,674,427 automatic couplers. In this report there have been continued several summaries, first presented in the report for 1902, to show the general type and efficiency of locomotives and the capacity of freight cars.

In these summaries locomotives are classified under the heads of single-expansion locomotives, four-cylinder compound locomotives, and two-cylinder compound or cross-compound locomotives. Each of these classes of locomotives is further classified according to the number of drivers and the number of pilot wheels and trailers.

ADVICE TO DRAFTSMEN.—Exercise your "gray matter" a little before doing things rather than "the boss's" patience afterward.

A rule is sometimes best observed in the breaking rather than the keeping. Heed the spirit as well as the letter of all instructions.

The men who make the pieces are not draftsmen and should not be supposed to know more about a piece than is given on the drawing.

A drawing is plainer to the man who makes it than to the mechanic who first sees it when he is started on the work. Consider what you would want to know if you were to make the piece correctly under the workman's circumstances.

Strive for clearness, completeness, simplicity and neatness.—*Edwin W. Beardsley—Machinery.*

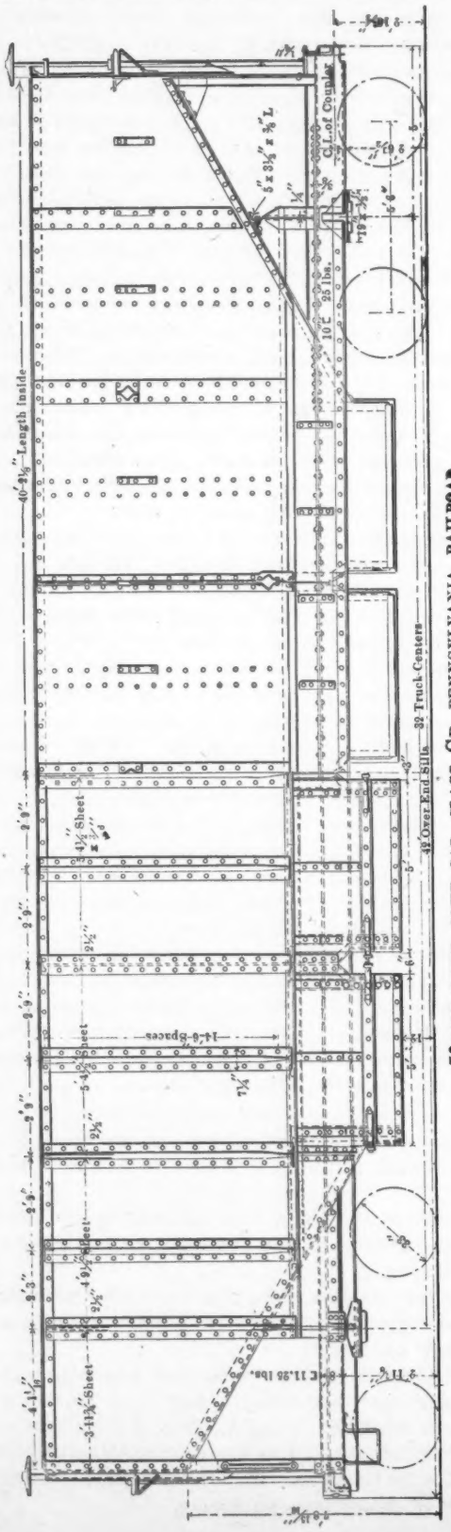
STEEL CAR EQUIPMENT.

PENNSYLVANIA RAILROAD.

VII.

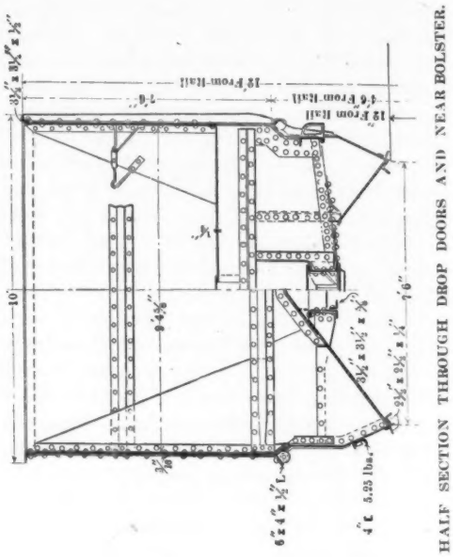
(*For Previous Article See Page* 148.)

The two classes of steel coke cars, designated as Classes GP and GPA employ structural steel frames and provide very large cubical capacity in an arrangement discharging the load through eight doors at the sides of the car. The two designs are similar in principle, the essential differences being in the 12-ft. sides of the GP class, which has no coke racks, and the 10-ft. sides of the GPA, which has coke racks.

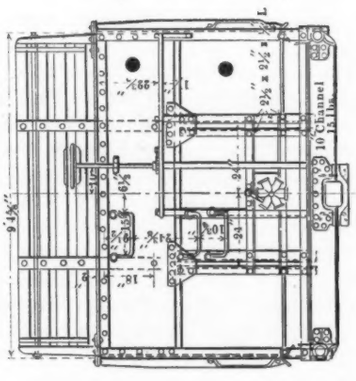


50-TON STEEL COKE CAR, CLASS GP, PENNSYLVANIA RAILROAD.

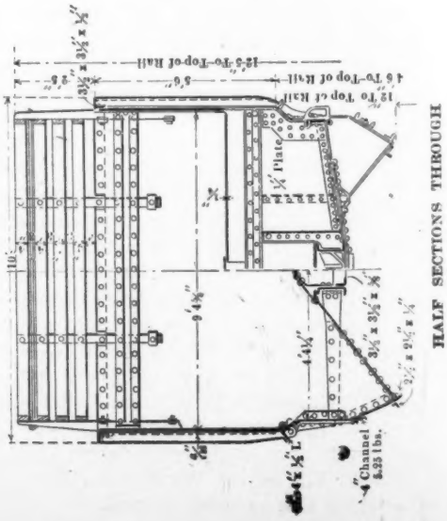
The table of dimensions indicates their very large cubical capacity, the leading dimensions and the weights. The back bones of these cars are of 10-in. 25-lb. channels for center sills, which are reinforced between the bolsters by 3½ x 3½ x ⅝ in. angles and by coverplates which extend on both sides of the bolsters from the hoppers to points near the ends of the car. These plates are ⅜ in. thick. There are no continuous side sills. Short side sills extend from the end sills to the hoppers. These are 8-in. 11.25-lb. channels, and they are built into the bolsters, which are very deep and are made in the form of single-plate diaphragms. In the sides of the car 6 x 4 x ½ in. angles act in a measure as side sills and form an angle for the hoppers as indicated in the sectional views. The side-



HALF SECTION THROUGH DROP DOORS AND NEAR BOLSTER. CLASS GP COKE CARS



END VIEW



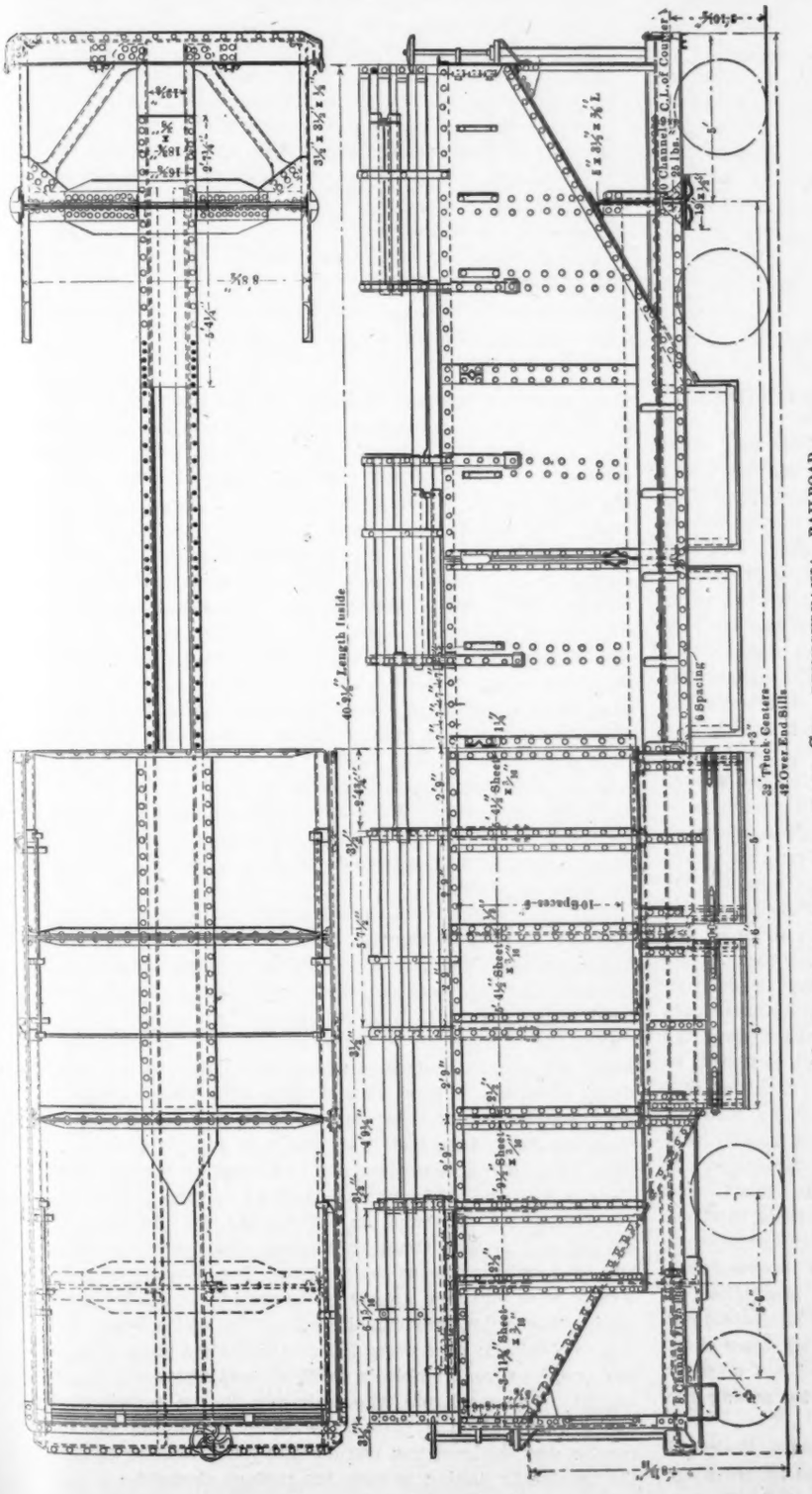
HALF SECTIONS THROUGH DOORS AND NEAR BOLSTER. CLASS GPA COKE CARS.

plating of these cars is of 3-16-in. material and the floor of ¼-in. The body bolsters extend backward and support the sloping floor by an attachment between a pair of 5 x 3½ x ⅝ in. angles. The floor of the car is given the form of a hood from the center sills and discharges the load towards the sides through 8 doors, which are 5 ft. long. The end sill construction and the corner bracing are the same in both of these designs, the end sill being a 10-in. 15-lb. channel with a ¼-in. plate on top to which the end posts and the corner bracings are riveted.

The door operating mechanism is actuated from one end of the car. An inclined capstan shaft operates joints leading to two longitudinal rods extending under the hood of the hopper at the center of the car. These rods operate 5 horizontal chain wheels, each of which carries 2 crank pins to which the door rods are attached. When in a closed position these crank pins are on dead centers and lock the doors. When the capstan is turned in an opposite direction the doors are opened positively. Both classes of cars are equipped with Westinghouse friction draft gear.

COKE CARS, PENNSYLVANIA RAILROAD.

	Class G. P.	Class G. P. A.
Length inside	40 ft. 2⅛ ins.	40 ft. 2⅛ ins.
Length over end sills	42 ft. 0 ins.	42 ft. 0 ins.
Height of side from rail	12 ft.	12 ft. 5 ins.
Width outside	10 ft.	10 ft.
Width inside	9 ft. 4⅝ ins.	9 ft. 4⅝ ins.
Truck centers	32 ft.	32 ft.
Cubical capacity, level	3,123.5	3,187.3
Cubical capacity, heaped	3,406.5	3,441.1
Nominal capacity	50 tons	50 tons
Light weight	52,500 lbs.	50,000 lbs.



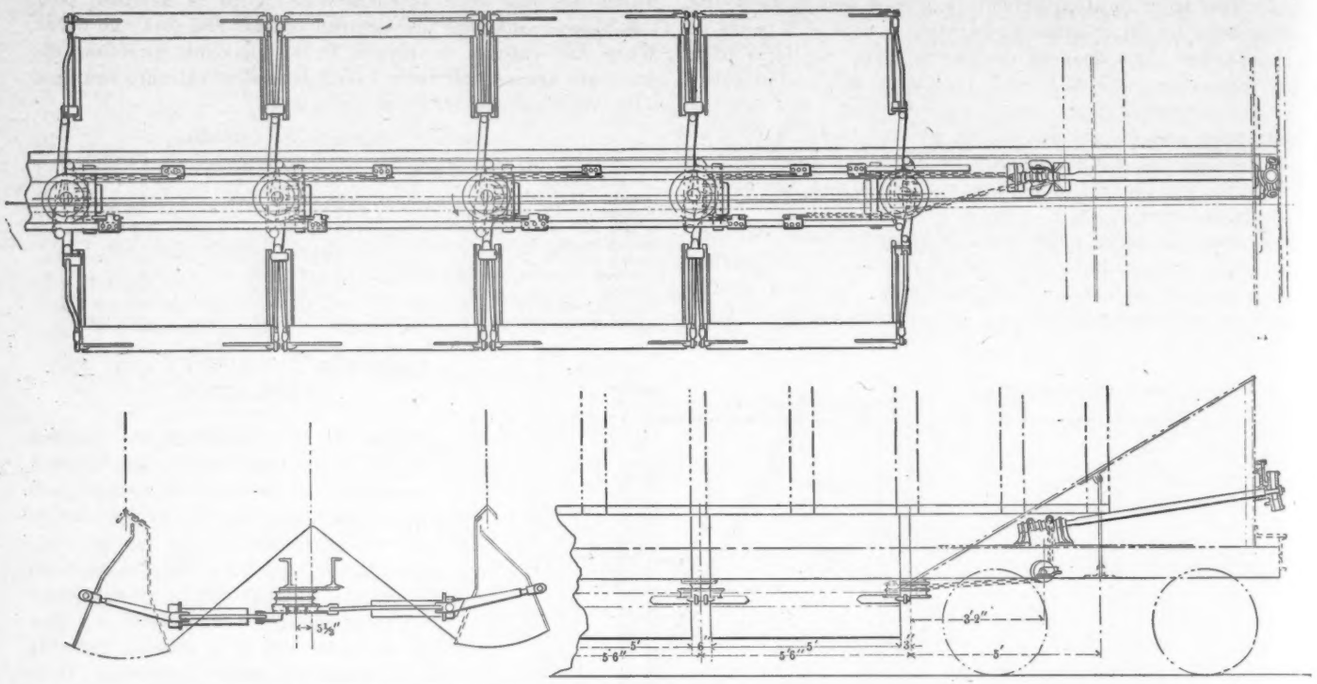
50-TON STEEL COKE CAR, CLASS GPA, PENNSYLVANIA RAILROAD.

INJECTOR STRAINERS AND SUCTION PIPES.

There can be little doubt but that the present suction pipe connection between the engine and the tender is a very inefficient makeshift. The life of the suction hose is short, and unless carefully attached is apt to buckle or collapse on short curves; the internal coil of exposed wire or a loose lining interferes with the free flow of water, and it is evident that this device could be easily improved. It is suggested that the foreign method of telescopic pipes is far better, if such arrangement could be made, with a simple form of joint and without leaks at the stuffing box. Similar devices are used on English roads and also upon some of the Continental systems.

It is generally acknowledged that the strainer is one of the chief sources of delay and trouble in the care and handling of injectors. Modern practice tends toward the use of a large pot strainer within or below the tender tank, with suitable means for quick removal and cleaning of the strainer plate. An objection to this system lies in the fact that neither the strainer nor the tank is frequently cleaned, and it is difficult to render such a device easily accessible; a simple and practical supplemental arrangement is to place a straining plate in a special body or casting at the lower end of the suction pipe and between it and the hose. A suitable opening with locking device is provided for the withdrawal of the straining plate, which should be made of heavy punched sheet copper full of small holes. Attempt has been made to clean strainers of this kind by admitting a jet of steam at the upper end, but this has not proven a commercial success, and has certain disadvantages. In all strainers, however, the diameter of the holes in the straining plate should be small, and the total area enormously exceed that of the suction pipe, to allow for the stoppage of a large number of the holes before the necessity is felt for removal and cleaning.—*Traveling Engineers' Association.*

Tests made at Melbourne have demonstrated the enormous strength of the Victorian eucalyptus. A piece of the wood 5 ins. thick withstood a strain of 27,650 lbs.



DROP DOOR OPERATING MECHANISM, CLASS Gp AND GPA COKE CARS—PENNSYLVANIA RAILROAD.

THE ORGANIZATION OF RAILWAY SHOP FORCES.*

Much has been written lately on the subject of shop tools; the very interesting discussion brought out by Mr. Barnum's paper in March (AMERICAN ENGINEER, April, 1905, page 133) showing to what extent it was appreciated. In that paper the writer said if he had to choose between old shops and new tools, or old tools and a modern shop, he would prefer the former, in which conclusion I agreed with him; we can carry these suppositions still further and ask ourselves whether it is better to have new tools and shops with a poor organization of shop forces or to have a good organization and comparatively old tools and shops. I would prefer the latter, and undertake to do more work in a given time than in a modern shop with a full complement of new tools and a poor organization.

In getting together a force of men sufficient to man a shop capable of turning out, say twenty to fifty locomotives a month (it really doesn't matter how many engines the shop turns out, the building up of an efficient force is very necessary in all cases), the first consideration is to pick a man for the head, whether as general foreman, master mechanic or shop superintendent, who can be implicitly relied on to carry out the plans you formulate for him, and to have such ideas of his own that he will immediately see where delay or friction occurs and apply a remedy. As head of the shop he must have a firm disposition, be prepared to meet emergencies, have the good will of the foremen and men under him and be tactful so as to be able to straighten out the many little difficulties that are continually arising; it is far better if he has no relatives or friends working for him, as it will save lots of trouble from fancied discrimination, etc. He must be an organizer in the true sense of the word, and every move he makes must be in the direction of increasing his output and decreasing the cost. He should not allow work to be done carelessly or improperly; it takes a long time to build up a reputation for thoroughness, which can be shattered in a few weeks if work is slighted. I am not a believer in frills and unnecessary ornamentation, but do think that it is poor economy to half do a job when most of the expense is incurred in getting to it, and not actually doing it, besides which it engenders loose habits among the foreman and men.

When an engine comes into the shop for repairs, it should be the duty of one or more men to inspect it, and immediately order all of the new material required and, see that it is placed at the machines or benches ready to be worked on when its time comes—don't wait two or three days after the engine arrives, and then find you want something that isn't in stock but ought to be; it will probably mean a delay to the engine going out, which might have been prevented if an earlier inspection had been made. In dissembling engines, each part should be plainly marked, so that when wanted again there will be no difficulty in finding it; the storage of parts that need no repairs is a matter worthy of attention; much material is lost through neglect in storing it away where it cannot readily be found when wanted. To get engines or work out of a shop there should be a classification of repairs and each piece of work done, or each engine passing through the shops should have a schedule of time, so that all concerned know when it will be necessary for the various parts to be ready. Don't do things haphazard. Set a time limit and work to it, making such improvements in tools, ways and means of doing work, etc., so that all lost motion is taken up, and the results you are after obtained.

The head of the shop should have good men under him as foremen, all of them knowing their business thoroughly, and at the same time being able to handle men with consideration, firmness and fair dealing; these combinations are frequently hard to get, but, with a large force of men to pick from, the right kind of men can be found who, by a little training, will meet the above requirements and soon get into his way of doing business. A good plan to adopt with your foremen is to hold weekly meetings for say an hour and review the work that has been done and that which is ahead of them. Let them tell you how conditions can be improved, what is delaying their work, etc. This getting together is very helpful to the superintendent of shops, as he quickly gets in touch with details, and at such times he can say what results he is after and offer encouragement to get them. The shop superintendent who is wise will lend an ear to suggestions made by his foreman or men when they can show a way by which better results can be obtained; once make light or ridicule a suggestion from any one, however humble in position, and another will not be offered. The mechanic who tells you that a certain casting has more metal on it than is necessary is helping you to get results, and the least you can do is to listen and try to remedy the trouble by asking to have the pattern changed.

The organization of shop forces does not end with the getting

*A paper by Mr. H. T. Bentley, asst. S. M. P., C. & N. W. Ry., read before the Western Railway Club.

together of good foremen and men; it is also necessary to have such a systematic arrangement of accounts and reports that you will not only see that the men are getting the work out promptly, but can tell at a glance how much is being done and what it is costing; without this knowledge you are not able to perfect the organization to its fullest extent; it also enables you to say, when asking for new tools, what can be saved in time and money by their introduction, and to know whether it will be cheaper and better to purchase supplies, taps, reamers, etc., or make them in the shops.

The superintendent of motive power who visits his shop frequently and knows all his foremen, can get better results and have the men feel more kindly disposed towards him than the one who does all his visiting by long distance telephone; a word of encouragement and a suggestion will often bring out latent ideas that otherwise might have lain dormant. It is natural for most men to like their superiors in position to come in personal contact with them and see what they are doing, and whether advantageously or not, hence, the advisability of the superintendent of motive power or his assistant making frequent visits to the most important shops and keeping in close touch with the shop superintendents and foremen.

A shop organization is not complete without some means of handling a fire, should one occur. A volunteer fire company, formed of the men who have been in the service some time and are likely to stay there, should be formed and a man put at the head who can handle them properly; they should practice at least once in two weeks, familiarizing themselves with fire hydrants, hose, etc. A little encouragement from the officials in charge will keep up enthusiasm, and at a critical time your volunteer company may be in a position to save you thousands of dollars and keep the shops from burning down and throwing themselves and co-workers out of employment. A watchman system, which will necessitate the patrolling of the shops at stated intervals, will often be the means of catching an incipient fire and enable it to be put out before getting beyond control. The checking-up of watchmen, to know that they are making their rounds at stated intervals, is necessary; it isn't enough to know they are on the payroll, you must know, through the medium of some check clock system (there are many good ones on the market), that they have faithfully discharged their duties.

The organization of forces includes, among other things, the prompt movement of work and tools to the men. What does it profit a superintendent of shops if he has a first-class machine and an up-to-date man handling it if he has to tie it up several times a day while he goes to get a tool dressed or sharpened, or the supply of material is not on hand when wanted. A sufficient number of tools, properly sharpened and dressed, should be available at all times, within easy reach of the mechanic, or, better still, have a boy who can keep the men supplied. A shop telephone system will aid in getting out work and will enable the foremen to quickly obtain information from each other, or from the shop superintendent and vice versa, and save endless running about, which is a waste of time and energy.

The placing of machine tools so that the minimum amount of handling material takes place, will increase the output and save a great deal of disorder and unnecessary work in moving it back and forth; where possible, a piece of work should travel from brass foundry, storehouse or blacksmith shop to the various machines so that it never makes a retrograde movement, and when completed should go direct to its resting place, which should not be around the man or machine finishing it. Always have plenty of unfinished work before your men, and remove that which is completed as soon as possible.

Labor-saving devices are a good thing, but they, like other good things, can be carried to extremes. Put an air or electric hoist where it will save delay in handling work, but don't put anything up that will cause a man to wait until some one else has finished with it, when without it he would have handled the work himself in a quarter of the time if no power hoist had been available. Pneumatic tools, hammers, drills, etc., are indispensable in doing work quickly and should be used wherever possible, but 50-ton hoists handling 50-pound loads is a waste of power, and should not be allowed. Keep your pneumatic tools in first-class shape and stop all air leaks—it saves the compressor.

The mechanical engineer, while not directly coming under the head of organization of shop forces, is, however, a potent factor in getting results. A bad feeling exists among foremen when castings or forgings come to their machines improperly designed or with more metal on than is necessary. The frequent breakage of parts that could be readily corrected is something that the mechanical engineer's office is often responsible for, and a man in this position who quickly corrects complaints that are made to him enables the shop organization to be perfected in a way that few people realize.

The boilermaker foreman finds out that an engine is coming into the shops for a new firebox: his organization would be very weak if he waited until the engine was actually in the shop before some action had been taken looking towards the building of a new firebox, so that as soon as the old one had been removed the new one would be ready for application; the same with engines requiring new side or flue sheets, the material should be on hand before it is needed, or much precious time is lost and the whole machine is temporarily disorganized.

The blacksmith shop generally is not a place that looks neat and tidy; there are, however, some notable exceptions to the rule, and orderliness pays there just as much as anywhere else. The turning out of duplicate work by machine instead of by hand makes a big reduction in cost, and the blacksmith foreman who can organize his work and men so that he is always in the van instead of the rear is a valuable addition to the shop organization.

The tank shop, tin shop, paint shop, brass and iron foundries, etc., deserve a word. It is not necessary for me to go into details about these shops, but they all play their parts in getting results; it is of no avail if the machine and erecting shops have the engines finished on time if they have to lay around two or three days waiting for the tender. All must work harmoniously or the results obtained will be unsatisfactory. The power plant is an important factor in the smooth running of a shop. Engines that are continually falling down or are too small to carry the load, and boilers that do not furnish enough steam, especially when the weather gets cold, are a trial and tribulation to the man who is trying to get there. Relay engines and boilers cost money, but often save shutting up shop when it can least be spared.

Apprentices should be given opportunities to learn their business thoroughly, as we depend upon them to make our future mechanics; if they are looked upon and treated as necessary evils we may expect indifference and indolence from them; but if treated properly and shown how to do their work efficiently and quickly they will, in most cases, turn out desirable men to keep in the shops. In our home life we endeavor to educate our children so they will grow up and be a credit to us and to themselves; then why, in our business life, should we not do the same with the young men who come to us for mechanical training? Special apprentices, who have graduated from a technical college, are invaluable if made of the right kind of stuff. In a large establishment conditions are often arising where some special information has to be obtained, which necessitates mechanical training, and a certain amount of technical knowledge to properly work up the data. In this field special apprentices can be used to advantage, and later, when they have completed their term of apprenticeship, if competent, they can be used in higher positions to advantage.

This is the age of specialists, and in hiring men you will find some who are first-rate mechanics in one line and not much good in another. The good all-around mechanic, like the old family physician, is disappearing from our midst, and instead, we get the air brake man, machine hand, the valve setter, the man who is handy at lining up guides, etc. Find

out what your man's strong forte is and use him at it, wherever possible; in a large shop this can be done to advantage with a corresponding increase in your output.

Always be on the outlook for promising timber in the shape of young, energetic and progressive men, and encourage them, so that when in want of a foreman or master mechanic you will know where to find one. Many a good man has been lost to the profession through lack of encouragement. Nothing stimulates a man so much as to know that his work is appreciated. Have we not all felt animated and enthused to do better when we have received a word of approval and praise? Some of us are prone to find fault, and we do that unsparingly, but how often do we give credit where it is due? Most of us, I am afraid, take it as a matter of course, and let it go at that; try the other plan occasionally, and see what results you will get. Don't have too many rules, bulletins and notices; they take up the men's time reading and discussing them. Only make such rules that you know can and should be carried out, and then see that they are lived up to.

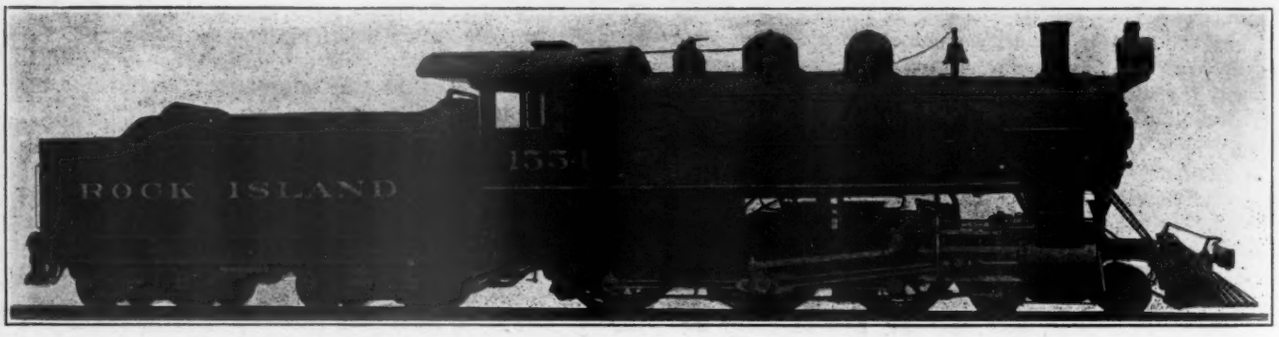
The motive power department organization can be demoralized and nearly put out of business if it is not backed up by the storekeeping and accounting departments. The prompt furnishing of material in sufficient quantities to keep machines going long enough to perform the work economically is a matter that must have attention, otherwise the cost will immediately go up. The setting up of some machines often takes longer than to do the work, if furnished in small amounts, and a direct loss to the company takes place. The furnishing of cost sheets within reasonable time after the work is done is very helpful in detecting increased or decreased cost, and applying the remedy in the former case before the matter gets old. In some shops messengers are used to deliver material, and they are great time savers when used in connection with a shop telephone system. The ordering of material is done by 'phone to storehouse, and deliveries are made from there by boys or men, thus obviating the necessity of high-priced mechanics going back and forth doing work that is just as well performed by cheaper labor. Nothing looks so bad in a shop as material, whether usable or scrap, being allowed to lay around indiscriminately—a man is frequently what his surroundings are; if neat and clean, he unconsciously, perhaps, becomes so; but where dirty and untidy, he would make it more so by throwing things down that he otherwise would be ashamed to do, if a proper example had been set him in orderliness. Some people think it doesn't pay, but try both methods and you will quickly find that a dirty shop is the most expensive to handle, and most unsatisfactory for all concerned. Have distinctive marks on scrap and usable material, and see that it goes where it belongs when once picked up—it is cheaper than to set it down and pick it up later on.

There are numerous other things that can be done to perfect a shop organization. I have simply given a few ideas which can be amplified according to requirements. In closing would simply sum up the whole by saying that the following requisites are necessary to get the best results: A good man at the head of the shop, good foremen under him, the education of foremen and men, proper control of men by foremen, punctuality, orderliness, system, harmony, prompt movement of material to and from the various departments, a good system of handling tools, the use of templets and jigs wherever possible, absolutely fair treatment of foremen and men.

FREIGHT LOCOMOTIVE 4—6—0 TYPE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

In the table of standard locomotives recommended by the Rock Island Power Committee, which appeared in this journal in March, page 84, two 4—6—0 designs were presented, the chief differences being in the size of the driving wheels. The purpose of the two sizes of the driving wheels in the 4—6—0 type is to provide locomotives which may be used in either passenger or fast freight service without using too heavy weights to be satisfactory over the entire system. The accompanying photograph illustrates one of thirty-eight locomotives built by the Baldwin Locomotive Works to which Walschaert valve gear has been applied. The extent of the use of the Walschaert gear in this case indicates the confidence which these builders have in it for the purpose of meeting present conditions of locomotive service. This design has balanced slide valves. It has a tractive power of 34,000 lbs., and the accompanying table presents the leading dimensions and ratios. In the August number of this journal, page 282, the Pacific type was described, and in the September number, page 329, the Atlantic type. Next month the six-wheel switcher will be presented.



FREIGHT LOCOMOTIVE, 4-6-0 (TEN-WHEEL) TYPE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

4-6-0 TYPE FREIGHT LOCOMOTIVE, CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

RATIOS.	
Tractive weight ÷ tractive effort	3.86
Tractive effort x diam. drivers ÷ heating surface	828
Heating surface ÷ grate area	57.6
Total weight ÷ tractive effort	5.11
Gauge	4 ft. 8½ ins.
Cylinder	22 ins. x 26 ins.
Valve	Balanced, Walschaert Gear.
BOILER.	
Type	Wagon top.
Material	Steel.
Diameter	68 ins.
Thickness of sheets	11-16 in. and ¾ in.
Working Pressure	200 lbs.
Fuel	Soft coal.
Staying	Radial.
FIREBOX.	
Material	Steel.
Length	96¼ ins.
Width	67¼ ins.
Depth front	72¼ ins.
Depth back	58 ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	9-16 in.
WATER SPACE.	
Front	4½ ins.
Sides	4½ ins.
Back	4½ ins.
TUBES.	
Material	Iron.
Wire gauge	No. 11.
Number	329
Diameter	2 ins.
Length	14 ft. 2 ins.
HEATING SURFACE.	
Firebox	160.8 sq. ft.
Tubes	2,426 sq. ft.
Total	2,586.8 sq. ft.
Grate area	44.9 sq. ft.
DRIVING WHEELS.	
Diameter, outside	63 ins.
Diameter, inside	56 ins.

Journals, main	10 x 12 ins.
Journals, others	9 x 12 ins.
ENGINE TRUCK WHEELS.	
Front, diameter	30½ ins.
Journals	6 x 12 ins.
WHEEL BASE.	
Driving	15 ft.
Rigid	15 ft.
Total engine	26 ft. 6 ins.
Total engine and tender	56 ft. 5½ ins.
WEIGHT.	
On driving wheels	131,200 lbs.
On truck, front	42,520 lbs.
Total engine	173,720 lbs.
Total engine and tender estimated	304,000 lbs.
TENDER.	
Wheels, No.	8
Wheels, diameter	33½ ins.
Journals	5½ x 10 ins
Tank capacity	7,000 gals. water.
Tank capacity	12 tons coal.
Service	Freight.

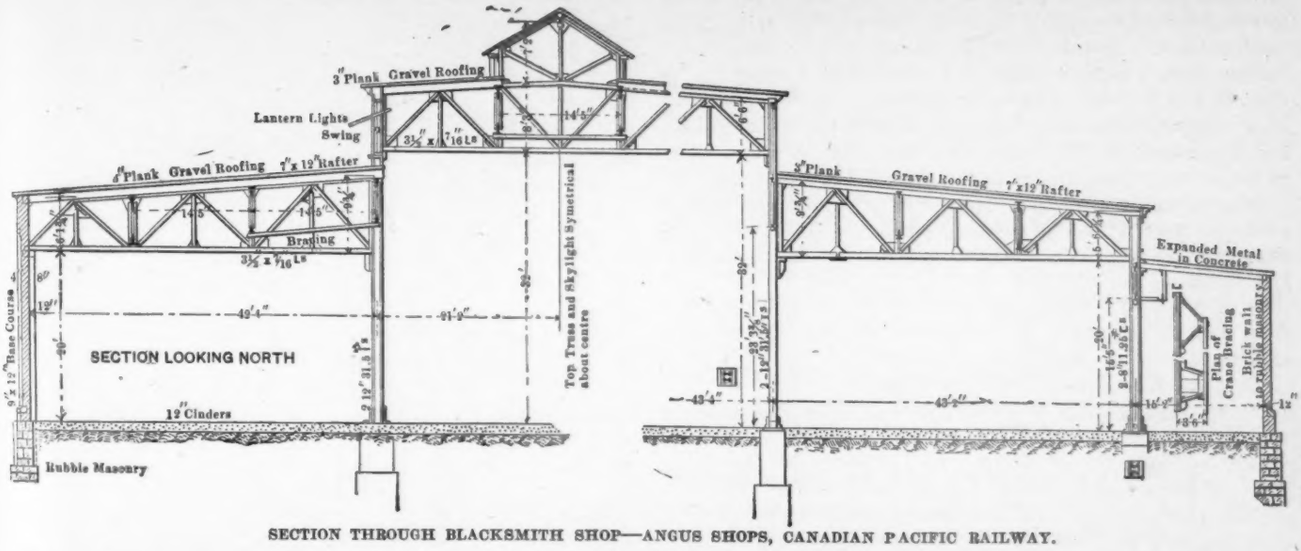
BLACKSMITH SHOP.

CANADIAN PACIFIC RAILWAY.

ANGUS SHOPS, MONTREAL.

This part of the plant of the Angus shops serves both the locomotive and car department, and for this reason is arranged in the shape of the letter L, and is placed under two separate foremen. The building is 434 by 300 feet; one of the wings is 146 feet and the other 130 feet wide. The location of the blacksmith's shop was shown in the general layout plan illustrated in December, 1904, page 451. The wing extending along the "midway" is occupied by the locomotive department machinery, and the other wing, which is nearer the car department buildings, is used for car work. It will thus be seen that the delivery of large quantities of material for the car department and the delivery of heavier material for the locomotive shop was carefully considered in its location.

INTERIOR VIEW OF BLACKSMITH SHOP—ANGUS SHOPS, CANADIAN P ACIFIC RAILWAY.


3" Plank Gravel Roofing
Lantern Lights Swing
3½" x 7/16 Ls
3" Plank Gravel Roofing 7" x 12" Rafter
Bracing
3½ x 5/16 Ls
SECTION LOOKING NORTH
12" Cinders
Rubble Masonry
Top Truss and Skylight Symetrical about centre
3" Plank Gravel Roofing 7" x 19" Rafter
Expanded Metal in Concrete
Plan of Crane Bracing
Brick wall

SECTION THROUGH BLACKSMITH SHOP—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

The cross section and interior photograph, which was taken during construction, show the character of the building, the large amount of glass and the interior arrangement. The roof columns divide the building into three bays of equal width, and for the accommodation of the large furnaces a 15-ft. concrete addition is built along the locomotive wing. The building covers an area of 84,200 sq. ft., and provides a large amount of space for the forging department. Oil is used in all the furnaces, the supply being piped from underground reservoirs back of the grey iron foundry. The longer wing has one central track from end to end, the shorter wing has two trans-

DOING IMPOSSIBILITIES.—A graduate of one of the leading technical schools some time ago obtained employment in our works. A month or two after his entrance he brought to me a paper, which I had prepared for the foundry work of the day, and said: "This must be a mistake; it is an evident absurdity, for the thing proposed to be done is an impossibility; we were taught that this cannot be done; it is opposed to all the principles of metallurgy. One of my classmates had a graduating thesis on this very subject last year." I said very quietly: "My dear boy, I do not question your word, but we have been doing this same operation on a large scale every day for ten years, and will no doubt continue to do so irrespective of what you were taught or even of the graduating thesis. This is a process which was devised in these works, and it has proved eminently successful. But I am not surprised that you did not know of it, for it has never been published and is carefully guarded as a trade secret."—*A. E. Outerbridge, before Wharton students.*

verse tracks and the long side of the shop has six tracks leading to the midway crane, all being standard gauge.

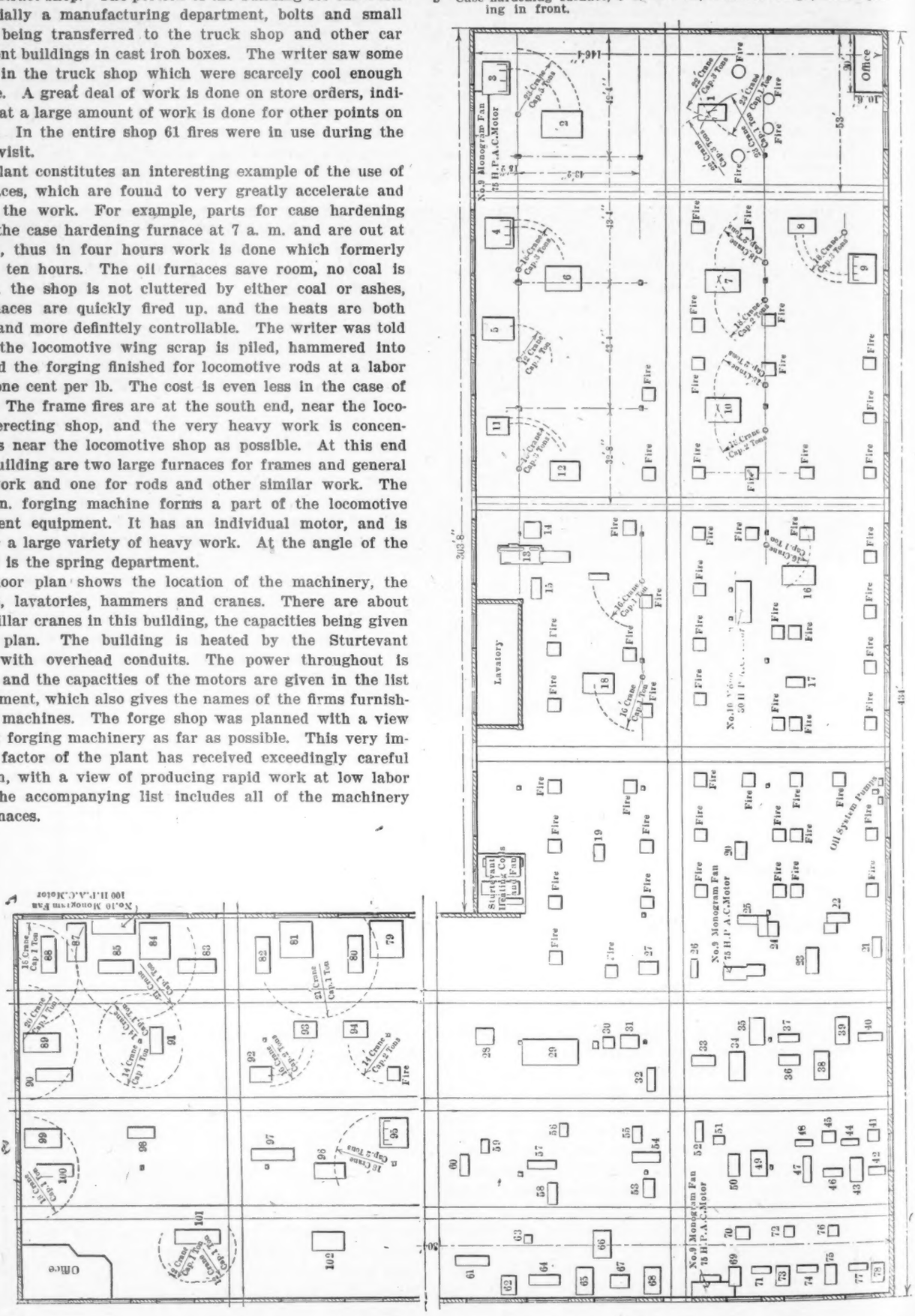
This is an exceedingly busy department—in fact, it resembles a contract shop. The portion of the building for car work is essentially a manufacturing department, bolts and small forgings being transferred to the truck shop and other car department buildings in cast iron boxes. The writer saw some of these in the truck shop which were scarcely cool enough to handle. A great deal of work is done on store orders, indicating that a large amount of work is done for other points on the road. In the entire shop 61 fires were in use during the writer's visit.

This plant constitutes an interesting example of the use of oil furnaces, which are found to very greatly accelerate and cheapen the work. For example, parts for case hardening go into the case hardening furnace at 7 a. m. and are out at 11 a. m., thus in four hours work is done which formerly required ten hours. The oil furnaces save room, no coal is required, the shop is not cluttered by either coal or ashes, the furnaces are quickly fired up, and the heats are both quicker and more definitely controllable. The writer was told that in the locomotive wing scrap is piled, hammered into slabs and the forging finished for locomotive rods at a labor cost of one cent per lb. The cost is even less in the case of frames. The frame fires are at the south end, near the locomotive erecting shop, and the very heavy work is concentrated as near the locomotive shop as possible. At this end of the building are two large furnaces for frames and general heavy work and one for rods and other similar work. The Ajax 5-in. forging machine forms a part of the locomotive department equipment. It has an individual motor, and is used for a large variety of heavy work. At the angle of the building is the spring department.

The floor plan shows the location of the machinery, the furnaces, lavatories, hammers and cranes. There are about thirty pillar cranes in this building, the capacities being given on the plan. The building is heated by the Sturtevant system with overhead conduits. The power throughout is electric, and the capacities of the motors are given in the list of equipment, which also gives the names of the firms furnishing the machines. The forge shop was planned with a view of using forging machinery as far as possible. This very important factor of the plant has received exceedingly careful attention, with a view of producing rapid work at low labor cost. The accompanying list includes all of the machinery and furnaces.

BLACKSMITH SHOP FURNACES.

3 Extra large forging furnace, 6 ft. 6 ins. deep x 18 ft. long, with two doors, for 6,000-lb. hammer No. 2.
4 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors, for 3,500-lb. hammer No. 6.
5 Case-hardening furnace, 5 ft. x 7 ft., standard design, clear opening in front.



PLAN OF BLACKSMITH SHOPS—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

9 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors, for 3,000-lb. hammer No. 8.
11 Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 1,500-lb. hammer No. 12.
15 Small forging furnace for upsetting machine.
21 No. 2 forging furnace for Beaudry hammer No. 22.
25 No. 2 forging furnace for Beaudry hammer No. 24.
26 Small forging furnace for brake key rolls.
28 Spring bending furnace, 28 ins. wide x 31 ins. deep, with one door, for buckle press.
29 Spring tempering furnace to be 15 ft. 6 ins. long and 5 ft. wide, to be furnished with eight doors, arranged four on each side, for four fitters and four helpers.
32 Spring tempering and nibbing furnace, for spring rolls No. 30.
33 No. 2 forging furnace for Bradley hammer No. 35.
36 No. 2 forging furnace for Bradley hammer No. 38.
37 No. 2 forging furnace for Bradley hammer No. 39.
40 No. 2 forging furnace for Bradley hammer.
42 Small forging furnace, bricked up, for bolt header No. 43.
44 Small forging furnace, bricked up, for eye-bolt machine No. 41.
46 Small forging furnace, bricked up, for bolt header.
48 Small forging furnace, bricked up, for eye-bolt machine No. 45.
49 Forging machine, 5 ft. deep x 28 ins. wide, with one door for continuous rivet-making machine No. 50.
52 Small forging furnace, bricked up, for forging machine No. 51.
55 No. 2 forging furnace for 2-in. upsetting machine No. 54.
58 No. 2 forging furnace for 3-in. upsetting machine No. 57.
62 Forging furnace, 31 ins. deep x 28 ins. wide, with one door, for nut machine.
65 Forging furnace, 5 ft. deep, 28 ins. wide, with one door, for nut machine No. 64.
68 Forging furnace, 5 ft. deep, 28 ins. wide, with one door, for nut machine No. 67.
71 Small forging furnace, bricked up, for bolt header No. 73.
74 Small forging furnace, bricked up, for bolt header No. 39.
77 Small forging furnace, bricked up, for bolt header No. 78.
79 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 15 h.-p. bulldozer No. 80.
81 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 20 h.-p. bulldozer No. 82.
84 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 15 h.-p. bulldozers Nos. 83 and 85.
87 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 15 h.-p. bulldozer No. 88.
89 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h.-p. bulldozer No. 90.
92 Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 2,000-lb. hammer No. 93.
95 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors for 2,000-lb. hammer No. 96.
99 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h.-p. bulldozer No. 100.

LIST OF TOOLS IN THE BLACKSMITH SHOP.

Machine No.	*Description.*	*Maker.*	**Motor H.-P.*
1	2,000-lb. Hammer, old,	Bement-Miles & Co.,	
2	6,000-lb. Hammer, new,	Bement-Miles & Co.,	
6	3,500-lb. Hammer, old,	Davy Bros., Sheffield,	
7	1,200-lb. Hammer, old,	Davy Bros., Sheffield,	
8	3,000-lb. Hammer, old,	Bement-Miles & Co.,	
10	1,200-lb. Hammer, old,	Davy Bros., Sheffield,	
12	1,500-lb. Hammer, old,	Bement-Miles & Co.,	
13	5-in. Upsetting Machine, new,	Ajax Mfg. Co.,	15
16	600-lb. Hammer, old,	Davy Bros., Sheffield,	
17	400-lb. Hammer, old,	J. Bertram & Co.,	
18	600-lb. Hammer, old,	Davy Bros., Sheffield,	
19	250-lb. Hammer, new,	Bement-Miles & Co.,	
20	250-lb. Hammer, old,	Bement-Miles & Co.,	10
23	Punch and Shears, old,	J. Bertram & Co.,	10
24	Beaudry Hammer, new,	Beaudry Mfg. Co.,	3
27	Flat Iron Saw, old,	C. P. R.,	5
30	Spring Rolls, new,	Craven Bros.,	5
31	Spring Taper Mach., old,	Craven Bros.,	5
34	200-lb. Hammer, old,	Bradley Mfg. Co.,	5
35	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
38	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
39	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
41	Eye Bolt Machine, old,	Wm. White & Co.,	3
43	1½-in. Bolt Header, old,	National Machine Co.,	5
45	Eye Bolt Machine, old,	Wm. White & Co.,	3
47	2-in. Forging Machine, new,	Ajax Mfg. Co.,	10
50	1½-in. Rivet Machine, new,	Ajax Mfg. Co.,	5
51	Forging Machine, old,	Ajax Mfg. Co.,	5
53	Single Shears, old,	J. Bertram & Co.,	3
54	2-in. Upsetting Machine, old,	Ajax Mfg. Co.,	10
56	2-in. Bolt Cutter, new,	J. Bertram & Co.,	3
57	3-in. Upsetting Mach., old,	Ajax Mfg. Co.,	10
59	2-in. Bolt Cutter, new,	J. Bertram & Co.,	3
60	2-in. Nut Burring, new,	Ajax Mfg. Co.,	3
61	3-in Forging Machine, old,	Ajax Mfg. Co.,	10
63	1½-in. Nut Burring Mach., new,	Ajax Mfg. Co.,	3
64	1½-in. Nut Machine, old,	National Machine Co.,	10
66	Nut Burring Mach., old,	Ajax Mfg. Co.,	3
67	⅝-in. Nut Machine, old,	National Machine Co.,	5
69	1½-in. Bolt Header, old,	National Machine Co.,	5
70	Round Iron Shears, old,	J. Bertram & Co.,	3
72	Round Iron Shears, old,	J. Bertram & Co.,	3
75	1½-in. Bolt Header, old,	National Machine Co.,	5
76	Round Iron Shears, old,	J. Bertram & Co.,	3
78	2-in Bolt Header, new,	National Machine Co.,	5
80	Bulldozer No. 6, old,	W. White & Co.,	15
82	Bulldozer No. 5, old,	W. White & Co.,	10
83	Bulldozer No. 6, old,	W. White & Co.,	15
85	Bulldozer No. 4, old,	W. White & Co.,	10
88	Bulldozer No. 5, old,	W. White & Co.,	10
90	Bulldozer No. 4, old,	W. White & Co.,	10
91	Punch and Shears, old,	J. Bertram & Co.,	10
93	2,000-lb. Hammer, old,	J. Bertram & Co.,	
94	1,200-lb. Hammer, old,	J. Bertram & Co.,	
96	2,000-lb. Hammer, old,	Bement-Miles & Co.,	
97	Punch and Shears, old,	J. Bertram & Co.,	15
98	Punch and Shears, old,	J. Bertram & Co.,	10
100	Bulldozer No. 4, old,	W. White & Co.,	10
101	Punch and Shears, old,	J. Bertram & Co.,	15
102	600-lb. Hammer, old,	Davy Bros., Sheffield,	

*All Motors Alternating Current.

MACHINES NOT SHOWN ON DIAGRAM.

1½-in. Bolt Header, old,	National Machine Co.,	5
Fire Brick Crusher, old,	C. P. R.,	
Hydraulic Buckles Press, new,	C. P. R.,	
4,400-lb. Hammer, new,	Bement-Miles & Co.,	
2,000-lb. Hammer, new,	Bement-Miles & Co.,	
2-in. Upsetting Machine, old,	Ajax Mfg. Co.,	
Eyebolt Machine, old,	Ajax Mfg. Co.,	
350-lb. Beaudry Hammer, old,	Beaudry Mfg. Co.,	5
200-lb. Hammer, new,	Beaudry Mfg. Co.,	
Brake Key Rolls, new,		

HYDROSTATIC TESTS OF LOCOMOTIVE BOILERS.

The object of hydrostatic test is to ascertain if the boiler is capable of sustaining some given pressure, and also to test the joints as well as the quality of workmanship. The only means we have of ascertaining with any degree of certainty the safety of a boiler, is by the application of pressure, which should be under conditions as similar as practicable to those of actual work. Let a boiler be ever so carefully designed and constructed according to the best knowledge acquired by careful research and long experience in the strength and disposition of its materials, and let every plate be tested before it is put in, there will still remain an element of doubt as to the actual strength of the boiler, since the material may have sustained injuries in the process of construction which may have escaped detection. In the case of a new boiler, even by a first-class maker, to say nothing of original and hidden flaws in the plates, bars, angle irons and castings, there is always a possibility of defects, such as bad welding, careless riveting, plates burnt in flanging or cracked in bending, and many other defects that may be traced to the want of skill or reckless negligence on the part of the workman. Many cases of dangerous defects which the strictest scrutiny of the completed boiler would fail to detect have been brought to light by the hydrostatic test combined with careful inspection.

The locomotive boiler does not admit of anything like proper examination. The expense of removing the tubes alone would forbid a periodical examination of the shell of boiler, and the water spaces around firebox are almost entirely out of sight, consequently a thorough examination is out of the question. In all cases there is only one means of testing the strength of the boiler, and that is—the application of pressure. We would not consider it practicable to allow a boiler to go through any of our shops for general repairs without having a hydrostatic test. This test to be applied before the boiler is covered, so that any defects that may be found through said test may be properly taken care of. When we consider that a locomotive boiler is constructed with a factor of safety of between 4 and 5, it would be impossible to injure the boiler in any way testing it at a pressure of 25 or even 50 per cent. above its rated working pressure.

The foregoing paper has dealt very largely with the testing of new work. To impress upon the minds of the readers that if such stringent means must be taken to insure a good, substantial boiler, they ought to be willing to confess that it is necessary to repeat this operation at least once each year, as a locomotive boiler, like ourselves, does not get any younger, but older and consequently weaker. From facts above stated the following conclusion should be drawn: That a periodical test at a pressure of at least 25 per cent. above the working load would be necessary and practicable.—*Mr. George Wagstaff, before the Central Railway Club.*

THE FOREMAN'S PLACE.—You men have no business to have your coats off when on duty in your shops unless you are warm. You have no business to take the tools out of a workman's hands to do his work. Your business is to secure results from other men's work. If I find that a foreman boiler maker on my road is doing the work that his men ought to do I begin to think that he had better keep using the hammer and chisel.—*Mr. Robert Quayle, before the Master Steam Boiler Makers' Association.*

UNDER-CONTACT THIRD RAIL FOR THE NEW YORK CENTRAL.

An under-contact third rail, details of which are shown in the accompanying illustrations, has been developed on the New York Central, and has several important advantages over the top-contact rail as regards safety and economy. The design originated with Mr. W. J. Wilgus, vice-president of the New York Central, and Mr. F. J. Sprague, and was perfected under the direction of Mr. Edwin B. Katte, electrical engineer of the New York Central.

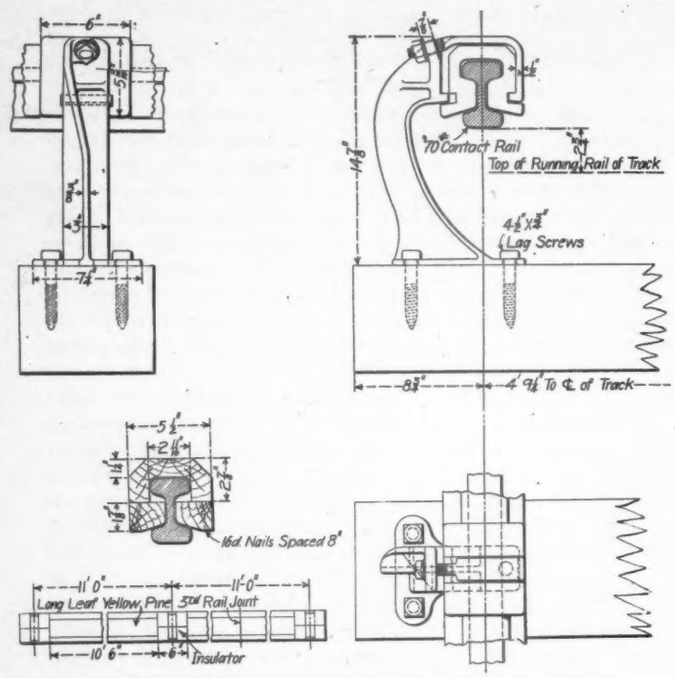


FIG. 1—DETAIL OF SUPPORTING BRACKETS AND WOOD PROTECTION, NEW YORK CENTRAL TYPE OF THIRD-RAIL.

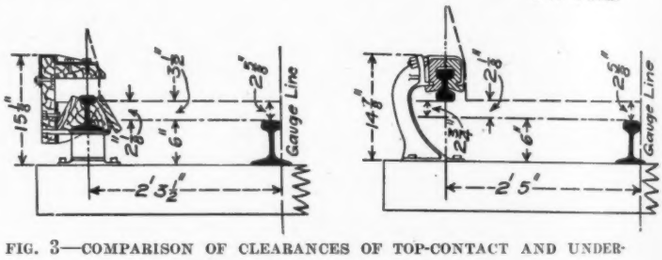


FIG. 3—COMPARISON OF CLEARANCES OF TOP-CONTACT AND UNDER-CONTACT THIRD-RAIL INSTALLATIONS.

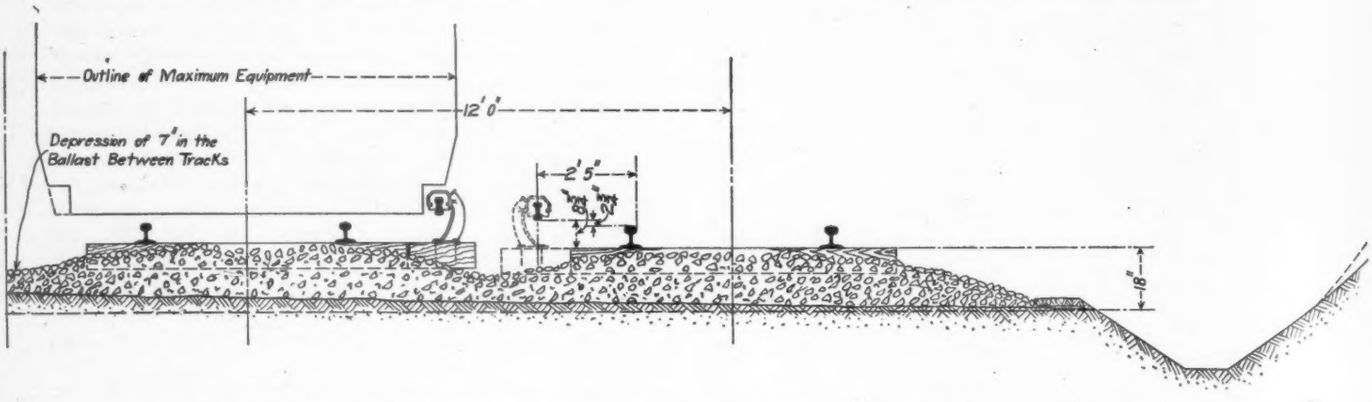


FIG. 2—HALF CROSS-SECTION OF STANDARD FOUR-TRACK ROADBED SHOWING LOCATION OF THIRD-RAIL.

The third rail is of a special bullhead section, 70 lbs. to the yard, and has a composition which gives it a high electrical conductivity. It is supported by cast iron brackets strongly ribbed, which are bolted to the ends of extension ties spaced 11 ft. apart. Insulators fit loosely over the top of the flange and web of the rail, thus allowing for some vertical play and providing for longitudinal motion due to the expansion and contraction caused by changes of temperature. A clamp fits around the side and top of the insulator, and is bolted to the top of the bracket. A glazed vitrified clay insulator has given the best results on the experimental track at Hoffmans, N. Y. The top and both sides of the rail to within ⅞ in. of the bottom are protected between the supports by three pieces of long leaf yellow pine, as shown. The third rails for a four-track roadbed will be located as shown in Fig. 2.

The relative location and appearance of the Subway or Long Island Railroad type of third rail installation and of the New York Central type is shown in Fig. 3. The center of the third rail is located 1½ ins. farther out on the New York Central type, but this will not interfere with the interchange of equipment, as a suitable shoe can be arranged which will automatically pass from one type of third rail to the other.

This type of third rail is thoroughly protected against accidental contact of any kind, and the trackmen may work with more freedom and use their time to better advantage than where the top-contact third rail is used. The cost of maintenance should be considerably less than for the top-contact type, since the contact surface is protected from snow or sleet, and the rail is less liable to corrosion; the board protection has a continuous support and is less apt to crack and warp; there is less strain on the insulators, as the pressure of the shoe acts against instead of with gravity. There is also a much greater space between the lower part of the rail and the cross-tie, and therefore less liability of leakage of current, due to the accumulation of snow, ice and ballast. The under-contact type requires only 7,600 parts per mile, as against 24,500 for the top-contact type, and this should reduce the cost of maintenance of the former. The under-contact type costs $4,100 per mile, as compared to $4,325 per mile for the top-contact type, or a saving of $225 per mile in favor of the former.

THE SELECTION OF ELECTRIC POWER FOR SHOPS.

The following reasons, underlying the selection of the electric power apparatus for the Readville shops of the New York, New Haven & Hartford Railway, are taken from a paper read before the New England Railroad Club by Mr. T. W. Adams, general foreman of the shops.

After determining on the use of the electric drive and having also decided it advisable to deliver the power to the shops in the form of alternating current, it then became a matter for very careful consideration as to whether alternating or direct current motors and lights were best suited to the particular local requirements, and in view of the isolation of the different machines to be operated, as to whether it was advisable to drive each machine with its own individual motor or to group them and so install the motors that one motor would operate a number of machines located in its own immediate vicinity. The capability of alternating current motors to handle heavy overloads for short periods without any ill

effects allowed of the installation of much smaller motors than would have been possible had direct current motors been used, and this made a very material gain in first cost of the motor equipment. The entire absence of commutators and brushes made the cost of maintenance also much less and, due to the inflammable nature of a great deal of the work, this last feature also made the alternating current motors highly desirable.

The transfer table required the use of a variable speed motor and it was found desirable to use a direct current motor which could be designed to give a much more gradual speed variation than was practical with the alternating current motors.

The matter of determining how far the subdivision of the power should be carried was also an item of very careful consideration and was approached from both extremes, namely, first, the individual connection of each machine to its own independent motor and consequent elimination of all shafting and belting. Second, the delivering of the power from the power station to one or two large motors so located as to deliver the power to the machines through the medium of long lines of shafting and belting was carefully considered. The first method was found to entail a first cost of more than was commensurate with the advantages obtained, and from the fact that small motors were less efficient than large motors, it then became necessary to determine if this loss in efficiency was as much as would be represented by the shafting and belting required by the second proposed method. It was found that the cost of the shafting and belting plus the cost of the large motors, while being less than the first cost of the first method, represented an efficiency loss which would represent more than the interest on the difference in the investment, and the two methods were brought nearer together, step by step, until a compromise of both was finally adopted, resulting in a very reasonable first cost and maximum efficiency in operation, which also resulted in a minimum cost of maintenance.

This compromise was to drive individually such machines as would occupy an isolated position and which were used more or less intermittently, and when used consumed power practically at full output of the motor by which it was operated (this plan was followed in blacksmith shop), and operating in common from one motor such machines as could be conveniently grouped without necessity for the use of large or long shafts and belts, and such machines as were operated with varying power, thus being able to use smaller motors than the aggregate maximum requirements of the several machines would indicate as being necessary, from the fact that the case would seldom, if ever, occur when each machine would call for the maximum power at the same instant, and, even if they should, it would occur so seldom and for so short a period as to be a matter of very little moment. This also resulted in reducing the first cost and increasing the efficiency of the system as a whole. It was finally decided that the polyphase motors were by far the most feasible and best solution of the question. Reliability, adaptability and simplicity were potent factors in their favor, and combined with the facts that they could be used on a long distance transmission and were free from sparking and moving contacts clearly proved the superiority of the polyphase system for this installation.

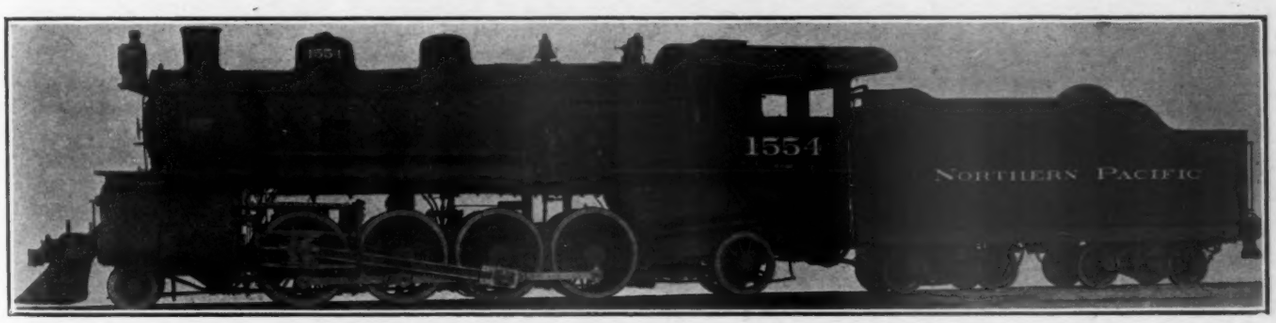
MIKADO TYPE FREIGHT LOCOMOTIVES.

Northern Pacific Railway.

In this journal in January of this year, page 5, the 2-8-2 type freight locomotives, built at the Brooks works of the American Locomotive Company, were illustrated and described, these locomotives being heavier and more powerful than any previous design for this road. In the description referred to, one of the single expansion 2-8-2 type locomotives was illustrated, and the fact was mentioned that six out of nineteen built at that time were tandem compounds. The accompanying engraving illustrates one of the second lot of tandem compounds which has just gone into service, being very nearly identical with the first order of this type and size. Reports of excellent performance of the Mikado type on this road indicate the wisdom of its selection, one advantage being a deep-throated fire-box, which is exceedingly advantageous in bad water districts. There is also a more favorable distribution of weight than can be obtained with the 2-8-0 type. The present design may be compared with the description already referred to. This tandem compound is exceeded in weight on driving wheels by only seven locomotives in our list of large locomotives, which appeared in May, 1905. These compounds have a cylinder ratio of 1 to 2.56. The accompanying table presents the usual list of dimensions and ratios:

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	44,300 lbs.
Weight in working order	271,000 lbs.
Weight on drivers	207,000 lbs.
Weight of engine and tender in working order	417,500 lbs.
Wheel base, driving	16 ft. 6 ins.
Wheel base, total	34 ft. 9 ins.
Wheel base, engine and tender	63 ft. 1 in.



FREIGHT LOCOMOTIVE, MIKADO TYPE—NORTHERN PACIFIC RAILWAY.

RATIOS.

Tractive weight ÷ tractive effort	4.67
Tractive effort x diam. drivers ÷ heating surface	696
Heating surface ÷ grate area	92.1
Total weight ÷ tractive effort	6.11

CYLINDERS.

Kind	Tandem compound.
Diameter and stroke	19 and 30 by 30 ins.
Piston rod, diameter	4¼ and 3½ ins.

VALVES.

Kind	14-in. piston and slide.
Outside lap	H.P., 1 in.; L.P., 1⅛ ins.
Inside clearance, low pressure	¼ in.
Lead in full gear	H.P., 1-16-in. positive; L.P., 1-16-in. negative.

WHEELS.

Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 and 9½ by 12 ins.
Engine truck wheels, diameter	30½ ins.
Engine truck, journals	6½ by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.

BOILER.

Style	Radial extended wagon top.
Working pressure	200 lbs.
Outside diameter of first ring	75¾ ins.
Firebox, length and width	96 by 65 ins.
Firebox plates, thickness	⅝, ¾ and ½ in.
Firebox, water space	4½ and 4 ins.
Tubes, number and outside diameter	374, 2 ins.
Tubes, gauge and length	No. 11, 19 ft. 6 ins.
Heating surface, tubes	3,798 sq ft.
Heating surface, arch tubes	9 sq. ft.
Heating surface, firebox	200 sq. ft.
Heating surface, total	4,007 sq. ft.
Grate area	43 5 sq. ft.
Exhaust pipe	Single
Smokestack, diameter	20 and 24 ins.
Smokestack, height above rail	15 ft. 10¼ ins.
Centre of boiler above rail	118 ins.

TENDER.

Tank	Water bottom.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,000 gals.
Coal capacity	12 tons.

LOCOMOTIVE TESTS WITH 250 LBS. PRESSURE.

Experiments carried out by Dr. W. F. M. Goss at Purdue University, under the patronage of the Carnegie Institution, developed exceedingly important facts concerning the use of 250 lbs. boiler pressure in locomotives. These tests are recorded in a preliminary manner in an article by Dr. Goss in the *Railroad Gazette*. It will be remembered that the Rock Island System in settling upon a boiler pressure to be used in their standard locomotives determined to adopt 185 lbs., preferring to sacrifice, if necessary, in economy to a slight extent, for the sake of avoiding the serious boiler troubles which have been increasing since pressures were augmented to 200 lbs. and over. The tests at Purdue tend to show that there is likely to be no sacrifice in efficiency due to this reduction of pressure and the possible result of the investigation is to attract attention chiefly to the advantages of lower boiler pressures.

The work at Purdue was directed toward a determination of a logical basis for establishing steam pressures in single expansion locomotives. It will be remembered that the experimental locomotive at Purdue was designed and built to carry 250 lbs. pressure with a view of ultimately determining this question.

Prior to the complete publication of the records results obtained when operating with a full open throttle under a pressure of 240 lbs. are reviewed. Some of the figures are given in the accompanying tables.

TABLE I.

	Steam per I. H. P. per hour.			
	Revolutions	Cut-off, per cent. of stroke		
Miles, per hour.	per minute.	15.	20.	27.
20	97	26.29	25.33	24.08
30	146	25.48	24.44	.....
40	195	24.16	23.86	.....
50	244	24.97	.....	.....

TABLE II.

	B. T. U. per I. H. P. per minute.			
	Revolutions	Cut-off, per cent. of stroke		
Miles, per hour.	per minute.	15.	20.	27.
20	97	442.3	425.8	405.5
30	146	424.9	407.4	.....
40	195	405.9	398.0	.....
50	244	418.1	.....	.....

These figures show the full range of operation under the pressure stated and it is shown to be possible to run at 40 m.p.h. with a 20 per cent. cut-off, but an attempt at 50 miles with the same cut-off failed for lack of steam. With a 27 per cent. cut-off 20 m.p.h. was possible, but an attempt at 30 miles failed. This represented a development of 500 to 575 h.p., a heavy load for a 16 x 24-in. cylinder locomotive and a boiler having but 1,322 sq. ft. of heating surface. Because of the importance of these experiments the following observations by Dr. Goss in the article referred to are reproduced:

"With reference to the economical results, it appears that the average steam consumption under eight different conditions of running is 24.57 lbs. per h.p. per hour, the best value being 23.86. From tests previously run, it is known that the performance for 180 lbs. pressure is 24.08 lbs., from which it appears that the performance for 180 lbs., when compared with that at 240 lbs., presents a difference of but .22 of a lb.; a difference too small to constitute a strong argument in favor of the higher pressure.

"A more careful study of all the data obtained indicates that further increase of pressure in locomotive service is not desirable, and strongly suggests the possibility that even present-day practice may exceed limits which in the end will be found most economical.

"It is well known that theoretical considerations show that the gain in economy to be secured from increasing steam pressures above 180 lbs. is at best small and the experimental facts which have been quoted indicate that in practice there is failure to realize all that theoretical considerations promise. The reason for this is to be found in the practical difficulties to be met in maintaining all parts of a locomotive tight under very high steam pressures. A boiler leak, either of steam or water, so slight as to attract little attention may easily amount to 100 lbs. or more per hour. A few such leaks materially impair the performance of the locomotive. The data of many tests have been entirely abandoned because of the existence of some conditions which upon the road would have attracted no attention, but which in the laboratory have been regarded as sufficient in their effect to entirely vitiate the results of the tests. Notwithstanding the fact that tests were run on alternate days only, leaving time for boiler makers and machinists to do their work, it was found impossible to keep the boiler perfectly tight or to prevent entirely the appearance of steam at the glands and drips about the cylinders. When it is remembered that this statement applies to a locomotive in the laboratory where it could be well cared for, it is not difficult to surmise the significance of such leakage as occurs from a locomotive on the road. Moreover, the benefits to be derived from higher pressure can only appear when the locomotive is working, while a portion of the leakage proceeds throughout the period during which it is under steam.

"It was found, also, in running tests at 240 lbs. that minor difficulties constantly presented themselves. For some of these, feedwater was responsible. The water used at the laboratory is from a driven well and contains some lime and magnesia. When used in stationary boilers carrying moderate pressure, it does not ordinarily form a hard scale but deposits a sludge which may be easily washed from the boiler. Its use for six years in the boiler of Purdue's earlier locomotive (Schenectady No. 1), for which the safety valve was set at the low pressure of 140 lbs., resulted in the formation of very little scale. During this period, a year or two elapsed between the visits of a boilermaker, and the boiler was perfectly tight practically all of the time. With this satisfactory record, when using low steam pressure, it is significant to note that the present locomotive (Schenectady No. 2), using the same water but carrying a higher steam pressure, has required the frequent attention of a boilermaker. After 30,000 miles running, new side sheets were inserted, and the leakage of tubes and staybolts have been of constant occurrence. It appears certain that the presence of solids in the feedwater which at the lower pressure gave little trouble, has seriously affected the operation of the plant at higher pressures.

"In addition to boiler defects there has been constant trouble with injectors and check valves. The injectors employed, while especially designed for the high pressure service, fill up very rapidly, due doubtless to the high temperature of the water delivered. It has been the practice when operating at 240 lbs. to clean the injectors between each run, but even under these conditions, tests have been lost through the failure of both injectors. It has been found that injector tubes will fill with lime so rapidly as to become inoperative after an hour's run, and check valves which have been clean at the beginning of a test have filled so that they would not close in the course of a single test. The fact seems to be that much of the solid matter which at lower pressure goes through the injector and passes the check into the boiler, is, under very high steam pressure, deposited in the injector and feedpipe.

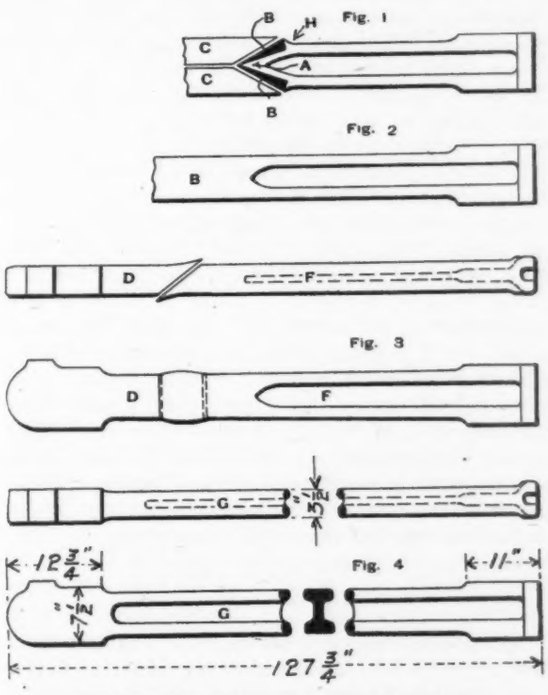
"In view of these difficulties, it was finally determined to improve the feed water. This was done by drawing water from a cistern receiving return from the heating coils of the laboratory building from which source it was possible to obtain from two-thirds to three-quarters of the total feed needed. The change greatly increased the certainty of operation though even the small amount of raw water then used manifested itself in the injectors and check valves, which still required to be cleaned after every test. It is in fact quite likely that a determination of the most desirable steam pressure for locomotive service must depend not only upon the economical performance of the engines and boiler, but also upon the purity of feedwater supply. In our western country, where feedwater necessarily contains a considerable amount of solid

matter, it will be found that the difficulties in maintaining and operating a boiler multiply with each increment of pressure.

"While a more precise statement of conclusions must await the full development of the present research, it may safely be said that an attempt to increase beyond limits now common the steam pressure upon American locomotives can only lead to disappointment. The possible gain is small and is likely to be more than neutralized by increased leakage while the difficulties of maintenance and operation multiply. It is not improbable that the final results will show that 200 lbs. which is a generally accepted standard of to-day is in our western country too high for best results."

FORGING AND REPAIRING LOCOMOTIVE MOTION RODS.*

In the past three or four years, what is known as low carbon steel has taken the place of iron in many cases to produce side and main rods as well as rod straps, consequently, the old method of forging and repairing these members, in a measure, has become obsolete and new methods have been adopted to meet the changed conditions. We are all familiar with the old method of producing these members from the best quality of



REPAIRING LOCOMOTIVE CONNECTING RODS.

scrap material. The method of utilizing scrap steel, similar to the old method of using scrap iron, is not yet in evidence for producing such important members of the locomotive as side and connecting rods, straps, etc. These members are forged from large steel blooms made for the purpose. Much more care has to be taken in forging such motion work from steel blooms than the old method of forging iron for the reason that steel is of a crystalline structure. The least imperfection in the steam hammer may cause a slight check in forging from the ingot or the slightest overlap worked into the forging will produce the nucleus for a break from vibrating strains when in service. The slightest nick with a sharp chisel on the finished surface of a steel rod will produce similar results. Many failures of steel rods have come to my notice in the last two years from the causes mentioned. Such defects may be produced in forging iron rods, as this material is of fibrous structure. The injury is not so pronounced as in steel, as one or two outside fibers are effected only, leaving the inside fiber intact, consequently the injury will not work its way into the metal to such an extent as it will with a metal of a crystalline structure.

Steel rods came into use in the Sacramento shops two or three years ago. Since that time I have had to repair many steel rods. In many cases, on examination, a slight check would present itself on the rib of a grooved steel rod. If the rod is low in carbon and will stand a high heat, the slight defect is easily remedied by cutting out the defective portion and welding a piece of good iron in the cavity by taking separate heats. If properly done this will prevent the original fracture from working into the rod from vibrating strains. The method practiced by many smiths of putting in what is termed a "Dutchman," from my point of view, is a very bad practice. This method is accomplished by splitting the defective portion and driving a wedge of iron in the split, then taking a welding heat on the upper surface of the rod and wedge and hammering the wedge and welding the iron over the defect. This simply hides the defect. I recently had a rod cut where a defect was repaired by this method. The sections of the rod showed the wedge in perfect shape, excepting a small portion of the surface.

We have many of these steel parallel rods coming into the shop with the defect so pronounced that it becomes necessary to cut the fractured portion off and put on a new end. Formerly the method practiced was to fill in the grooved portion of the rod with good iron, as well as the projecting ribs, continuing the iron portion about 8 in. from the broken section, then welding on the iron portions by the usual method of male and female scarfs. This method was not entirely satisfactory as we invariably found a slight defect on the surface of the grooved portion, when the groove was planed out of the repaired section.

Recently the Southern Pacific has been changing the heavy compound engines to simple engines. It became necessary to lengthen the main steel connecting rods; this is accomplished by welding on new ends. The original method as explained was not satisfactory. I adopted the method as shown in Figs. 1, 2, 3 and 4. We cut off the end that had to be renewed. The end of the old portion of the rod to be welded was upset with a battering-ram. Then by means of a steam hammer a point was formed on the end of the rod as shown at A, Fig. 1; this produces a round corner at H. To overcome this we raise a fillet at this point by cutting into the metal slightly and driving the metal back with a fuller. We then lay two pieces of iron, B B, on each side of the V-shaped end of the rod, firmly welding them to the steel. Now we have the end of the rod shod with iron. This being accomplished, we have iron to iron welds and can get high heats without bringing the steel to an injurious heat. We now bring our two pieces, C C, to a welding heat in separate fires, welding them on to the surface B B, under the steam hammer. Another welding heat is now taken for the purpose of forming a perfect union of all of the parts as shown at B, Fig. 2. The remainder of the work is done by the ordinary method of lap welding under the steam hammer as shown at D F, Fig. 3. The portion D is forged by the steam hammer from the best scrap iron obtainable. The rod being finished as far as the forging is concerned goes to the machine shop to have the new iron portion finished and grooved as shown at G, Fig. 4. When the rod is being finished the slightest defect in the welded portion will be discovered.

There have been 40 rods welded by the above method in the Southern Pacific shops in the last eighteen months. A slight defect in the welded portion was found in one case only. Not a single rod has failed in service.

*From a paper by Mr. S. Uren, read before the National Railroad Master Blacksmiths' Association.

RESULT OF MASTER MECHANICS' LETTER BALLOT.—The secretary of the Master Mechanics' Association advises that the recent letter ballot resulted in the adoption of the specifications for locomotive driving and truck axles, the specifications for locomotive forgings and the specifications for steel blooms and billets for locomotive forgings.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

G. M. BASFORD, Editor.
R. V. WRIGHT, Associate Editor.

OCTOBER, 1905.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the*
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St. S., Minneapolis, Minn.
Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C., London, England.

Advertisements.—*Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The AMERICAN ENGINEER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*
When a subscriber changes his address *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

MR. GEORGE M. BASFORD.

It is with deep regret that the announcement is made of the retirement of Mr. G. M. Basford as editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL. For nearly eight and a half years he has been in charge of its editorial management, and it is unnecessary to speak of the character and the earnestness of his work or of its effect in placing the paper in its present position among the technical journals. In laying aside journalistic work, Mr. Basford's name may be placed with those of Barnes, Wellington, Forney, Marshall and Prout for years spent in unstinted devotion to a profession which is difficult and not too full of encouragement. All of these men have inspired many others, and by words and helpful acts have urged and aided young men toward advancement and improvement.

Mr. Basford has fought the battle of the motive power department consistently and systematically, maintaining that it should be properly and fittingly recognized because of its real importance in the organization of railroads. His views on this subject are not new to the readers, but perhaps the reasons for his opinions on the subject of apprenticeship are not known. After several years of service in various kinds of engineering work he entered the Massachusetts Institute of Technology and was graduated in 1889 in mechanical engineering. He entered the shops of the Boston & Maine as a laborer, and there he began his study of apprenticeship and recruiting. Later he went to the Chicago, Burlington & Quincy as a draughtsman at Aurora, and afterwards served in various capacities in the mechanical departments of the Burlington, the Union Pacific and the Chicago, Milwaukee & St. Paul roads. He served the last mentioned road as signal engineer, and afterwards spent several years in the signal business in Chicago. In January, 1895, he became engineering editor of the *Railway and Engineering Review* in Chicago, where, in two years, he became known by his work.

In May, 1897, Mr. Basford became editor of this journal, succeeding Mr. M. N. Forney and Mr. W. H. Marshall. The manner in which he handled his difficult task is told by the paper itself, and requires no comment or praise. Mr. Basford's standing among the railroad officials is shown by the testimonial given him two years ago and the high regard in which he is held by the younger railroad men is best seen in the constant stream of these young men to the editorial rooms of this paper when they have troubles to tell about or advice to ask. It is understood that in his new work he is to continue much that he began in his newspaper work, and that, among other things, he is likely to be called upon to put into practice his ideas as to apprenticeship.

His associates, including the proprietor of the AMERICAN ENGINEER, wish him the success which he is sure to win in the new field, and congratulate the American Locomotive Company upon securing him.

Railroad repair shops probably use more machine tools than any other one metal working industry in this country, and yet we find that only a few of the machine tool builders have devoted any special study to this field. Those who have done so have found the railroads ready to co-operate with them in their efforts to improve or adapt their tools to the work. The larger number of machine tool builders, although they have sold many tools to the railroads, have never made any special effort to follow them up and see what class of work they were doing or to find out what satisfaction they were giving. Some of them have sold their tools to the railroads through agents, and cannot even tell at what shops they were installed. The purpose of this editorial is not to give the impression that the machine tools used in a railroad repair shop should deviate greatly from the standard machines, but rather that often a few slight changes from the standard or the addition of special attachments will greatly improve the output of the machine for special work, and will afford much more satisfaction to the user. A system for following up the tools could be installed and conducted without any great amount of expense, and would certainly repay for itself many times over if intelligently handled. A case was recently called to our attention where a machine tool builder had occasion to visit a certain railroad shop, and after examining some of the work which was being handled on one of his standard machines was enabled to make certain changes on a new machine which he was about to install which made it possible to practically double its capacity over the standard machines for this class of work.

A correspondent speaks plainly on the subject of water purification in a recent letter which we would like to print in full. He says that the time has passed when the motive power man can safely be tied hand and foot and asked to give "results" with bad water. He says it is now too late to say bad water was in the beginning, is now and ever shall be. "How many roads are spending thousands of dollars on the effect and not a cent on the cause?" "When we consider the increased demands on the equipment, increased wear and tear because of increased weight and heavier business, it is pertinent to ask if we may fairly expect to secure the returns looked for from the vast sums of money invested in new shops and improvements of like nature, unless the policy is changed to deal only with the effect and ignore the cause." While large sums have been spent by some roads in improving their water supply only a beginning has been made and it is in this direction, that of attacking the cause, that the improvement of the future lies rather than dealing with the effect. To deal with the water purification question effectively has proved to be excellent business policy both from the standpoint of the locomotive operation, and also to relieve the shops and roundhouses of a vast amount of work which increases with the weight of locomotives and the increased demand upon them.

A machine tool manufacturer with a broad smile on his face, recently stated to the writer, who was examining a newly designed engine lathe, which was remarkable for its compactness of design and for the convenience with which the operator could control its various movements, that the next improvement would be to furnish a chair for the use of the operator which would travel with the lathe carriage and could be swung back under the bed when not in use. The improvements which have been made in machine tool design during the past few years are wonderful, and it would seem that the limit of development has almost been reached in the design of the standard machines. The machine tool builder has done his part. It is now up to the shop manager to produce results and to place his methods of handling the men and the work on the same high plane as the design of the modern tools. If we may judge from the results which have recently been accomplished in some of the more progressive shops the possibilities of increased output and greater economy, due to the introduction of improved methods of operation, are even greater than the combined results due to the modern machine tools, high speed steels and improved methods of driving machine tools. Mr. H. T. Bentley in his valuable paper on "The Organization of Railway Shop Forces" on another page of this issue, emphasizes this very strongly in saying that he would prefer and undertake to do more work with comparatively old shops with old tools, but with a good organization than with a modern shop with a full complement of new tools and a poor organization.

REPORTING LOCOMOTIVE DEFECTS.

"No steam, right injector not working, pound on the right side, bad coal." Such reports as these are often made by enginemen.

It is impossible to keep locomotives up to proper condition with reports of this character, because roundhouse forces are not given sufficient information to correct the difficulties. When an engine is cold in the roundhouse it is impossible for the men to discover the exact cause of the trouble and in many cases the necessary work is not done.

Many motive power officials complain of the indefiniteness of the reports of enginemen and they say it has grown worse with the increase of pooling. Undoubtedly if the men realized the importance of it they would be more explicit in their statements. On some roads such reports are not permitted, the men being required to know where the pound occurs, what the trouble with the injector is and why the engine does not steam, or if they cannot tell positively they are required to give an intelligent opinion.

It is not unreasonable to expect an engineer to know quite definitely what is wrong, and where such difficulties occur it seems fair to predict that great good would result from closer relations between the traveling engineer and the men. Would the owner of a $20,000 horse accept from his driver a statement that the animal was lame, or otherwise not right? He would certainly be justified in expecting the man to take sufficient interest in his charge to know where he was lame or what was wrong. It cannot be believed that the men who are entrusted with modern locomotives are not capable of satisfactory diagnosis.

"Poor coal" is generally accepted as a reason for engine failures on most roads. There seems to be some mystic power in these two words. With proper management of the fire, "poor coal" should never lead to an engine failure. Are the locomotives designed for the coal they must use? Do the firemen receive the amount of instruction in the use of fuel that the importance of their work requires? Does the engineer feel sufficiently responsible for or interested in the work of his fireman to give him the benefit of his experience? Anything which will increase the interest of the men in their work will help these matters along wonderfully. In Europe premiums to the engineer and fireman have accomplished wonders in these directions.

AN UNDESERVED SLUR.

"We wonder if the railway presidents do not often wish that the electric motor had never been invented."

This soliloquy, quoted from an editorial in a well-known electrical journal, reflects a view of the opinion of steam railroad officers which does little credit to the rampant advocates of electric traction. If these advocates do not find progressiveness among railway presidents, where do they find it? Who is making better use of electric motors than the steam roads, and what class of men is more ready to adopt anything new and radical, providing it will pay its way financially?

The change from direct steam to electric traction on the Lancashire & Yorkshire, in England, those of the Baltimore & Ohio in its Baltimore tunnel, and the work of the Pennsylvania and New York Central terminals in New York eclipse all other electrical projects in boldness and in extent. In these instances the steam railroad men have taken the initiative, and the electrical men have responded, and responded ably. Electricity was sought because it was needed, and the railway presidents were the first to see the need. They presented problems which the electrical people considered experimental in that they could turn to no precedent or example.

It is idle to advocate electric motors for heavy traffic conditions generally to-day. Everybody knows that it will not pay to electrify a main line division having comparatively few train units. The determining factor is the traffic. Instead of belittling the men who have made American railroad systems, those who understand electric traction can expend their energies to better advantage by preparing for the rush which the steam railroad men are nearly ready to present.

DRAFTSMEN.

Of late there has been an increased demand for competent draftsmen, which indicates a marked change and improvement in the status of the draftsman. This is noticeable not only in the number of inquiries for good men, but in salaries which are being offered them. The salaries offered are none too large, but they are much better than those of a few years ago. There is probably no factor in the motive power department capable of such improvement as the drafting room. The strongest motive power officials lean hardest upon their drafting rooms and a study of their needs leads to the conclusion that the possibilities of the draftsman are not by any means exhausted.

Some time ago a motive power officer said, "The greatest trouble I find among the draftsmen is their inability or helplessness in doing things. All seems to go well enough if I put in their hands every particle of information, but should one item be omitted they seem unable to know where to look for the missing data."

It has been shown to be possible for the drawing-room as a department to not only walk alone but to be a dealer in very important problems. It is quite possible that those who do not find their draftsmen a necessity of the most important kind may be themselves to blame. The draftsman is not in any sense a necessary evil. He is intelligent, and is trained to think and to plan. He is most valuable if he is encouraged by being treated as a part of the working organization. If he is trusted and is given responsibility he grows to be a vital element as a constructive factor in the organization. The draftsman occupies such a position on many roads but on many others, and probably a large majority, is not treated in such a way as to bring out his possibilities. Some superintendents of motive power do not derive the full measure of support and assistance which is available by the complete development of the draftsman's position, and hence the development of the draftsman is often far short of what it ought to be. Draftsmen, however, ought to see a great deal to encourage them in the improvements of the past few years.

PRODUCTION IMPROVEMENTS.

TRUCK FOR DRIVING WHEEL TIRES.—L. S. & M. S. RY.

The truck shown in Fig. 1 affords a very safe, quick and convenient means of handling driving wheel tires. With this device two men can easily handle the largest size tires without difficulty and with no liability of personal injury. Without the truck six men are usually required to handle one of the large tires in the yard, and four are required for handling it inside the shop. The illustration shows an 80-in. tire on the truck. To pick up a tire the hook shown just below the axle, and which serves to stiffen the truck when loaded, is unhooked, the truck is moved over the tire, the truck handle is lifted a short distance and a 1-in. pin is passed through the uprights just below the rim of the tire. When the truck handle is lowered the tire is raised off the ground, as shown.

MANDREL FOR DRIVING BOX BRASSES.

A mandrel for driving box brasses is shown in Fig. 2. The practice is to adjust the first driving box brass of a lot on the mandrel by manipulating the set screws. After the first one is set other brasses of the same kind are mounted by dropping them on the set screws and tightening up the end nut. To adjust the mandrel and set the first brass ready for turning requires about ten minutes, and subsequent brasses of the same kind are mounted in about three minutes. The time required for mounting, taking rough and finishing cuts and dismounting the brasses after the chuck has been set for the first one is about eighteen minutes. The mandrel illustrated is the larger one of two sizes which are in use.

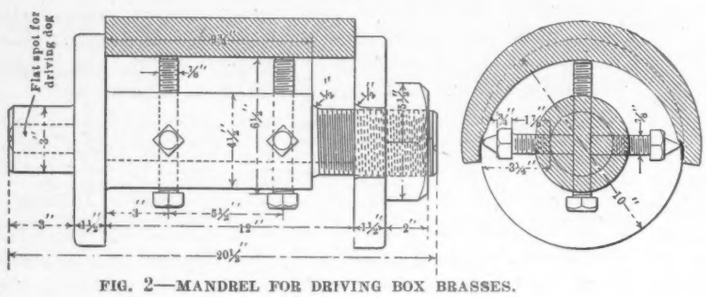


FIG. 2—MANDREL FOR DRIVING BOX BRASSES.

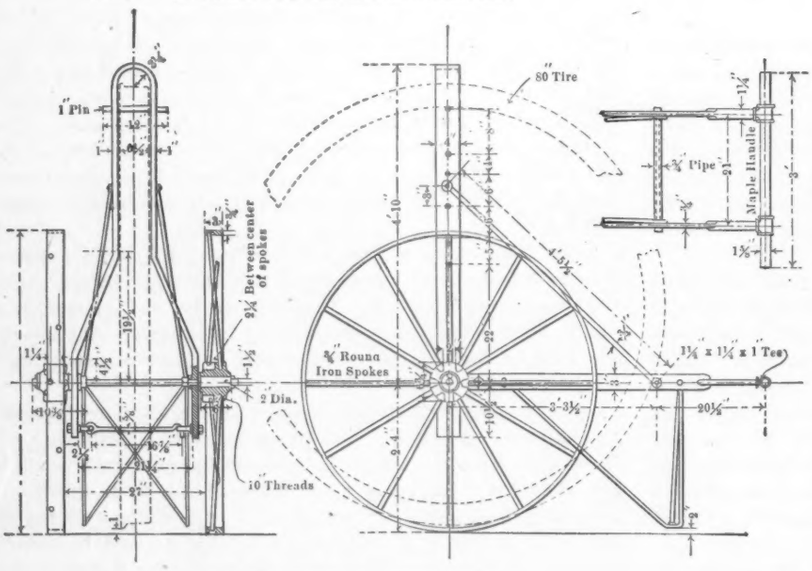


FIG. 1—TRUCK FOR DRIVING WHEEL TIRES.

TOOL FOR REMOVING PISTON RODS FROM CROSS-HEADS.

A very substantial and efficient device for removing piston rods from cross-heads, and one that is well adapted to stand the rough usage which the nature of the work demands, is shown in Fig. 3. The pin portion of this device replaces the cross-head pin after it is removed. The slight taper of the key makes the device very powerful.

EXPANDING REAMERS FOR ROD BUSHINGS.

The expanding reamer for rod bushings, shown in Fig. 4, is set 1-64-in. larger than the crank pin, and the bushing is reamed to a smooth, finished surface and accurate size in much less time than by other methods. The bushings are, of course, rough-bored before being placed in the rod.

We are indebted for drawings and information to Mr. C. W. Cross, master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind.

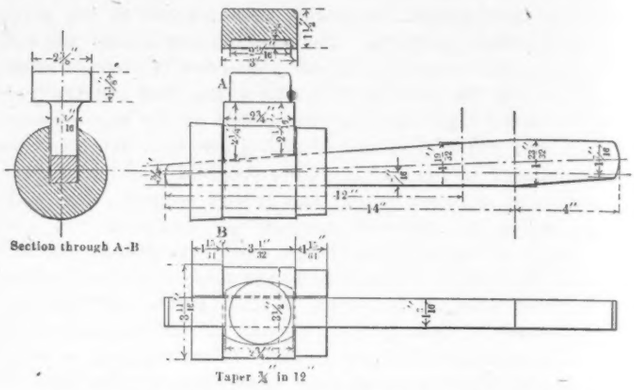


FIG. 3—TOOL FOR REMOVING PISTON RODS FROM CROSS-HEADS.

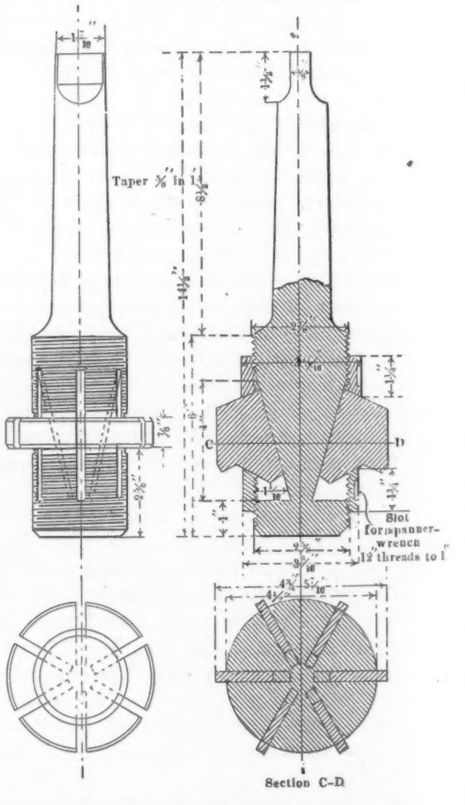


FIG. 4—EXPANDING REAMER FOR ROD BUSHINGS.

AUTOMATIC DOOR OPENERS.—One of the best labor-saving devices we have found for a long time is the pneumatic fire-door operator. The operating lever is placed in such a position on the deck of the cab that the fireman by placing his foot on it opens the door, by moving his foot away the door is closed, thus insuring the swinging of the door between shovels of coal and also preventing chilling of the flues by permitting the door to remain open longer than is necessary. A device of this kind should be applied to each locomotive.—*Traveling Engineers' Association.*

RESULTS OF WATER PURIFICATION.

Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, in speaking before the New York Railroad Club, said that ten purifying plants were now in operation on that road, and five more were to be installed. Treated water has been used in a sufficient degree during the past eighteen months to make the observations reliable, and it is now well understood what can be expected from the investment. The water supply is taken from 6 different rivers, no two presenting the same analysis. The greatest trouble that has to be met is acidity, at times and places being as high as 35 grains to the gallon, and one-third of this being free sulphuric acid. The second disturbing elements are sulphates of lime and magnesia, and the third are carbonates of lime and magnesia.

Our past experience has demonstrated that we have the worst water from the first of August until about November 1st, or until the heavy fall rains commence. During this period the river supply is largely made up of drainage from the coal mines, and during one particularly bad season, prior to the use of treated water, three shifting locomotives, new and direct from the manufacturers, were sent to one point in the acid district in June. Early in September of the same year every tube in the three locomotives was removed and scrapped, being totally unfit for further service

Before treated water was used it was not an uncommon occurrence to find in locomotives that had worked largely in the districts where incrusting solids predominated, such an amount of mud and scale as to entirely obstruct all circulation in portions of the cylindrical part of the boiler, and there would be from 15 to 40 tubes collapsed and worthless. During the latter part of each year troubles multiplied rapidly, and on such locomotives as were not filled up with scale and burning out, the sheets and tubes were being eaten up with acid and failures on the road were not the exception, but the rule.

Before treated water was used it was the rule to wash out boilers once for each seven to ten days of service. After the treating plants were installed, the time between washouts was gradually lengthened until, under favorable conditions, where the movements of the power could be controlled and nothing but treated water provided, they were run for forty-five days between the times the washout plugs were removed. However, the materials which were used to soften the water, precipitate sludge, and neutralize the acid, causing the boilers to foam, making it necessary to change the water at intervals of about five days. This feature is easily taken care of by equipping the engine-houses with facilities for hot water boiler washing, and when properly designed the water can be blown out of the largest boilers, the boilers refilled without dumping the fire, and the locomotive made ready for service in thirty-five minutes. The amount of scale and mud taken from a boiler that has run for forty-five days with treated water will approximate about the same amount as one run for seven days with untreated water, with this difference, that quite a percentage of the stuff removed from the boiler using treated water consists of scale which has loosened up and come down and was made before treated water was used. Corrosion of tubes and plates has become a thing of the past. The claim or statement is not made that we are entirely free from scale in our boilers; this may be so when nothing but treated water is used.

Another feature is the economy found in keeping the boilers comparatively free from scale, resulting in better conditions of heat and a consequent increase in number of miles run per ton of coal, which during the year 1904 was increased 5.7 per cent., with an increased trainload of 6.5 per cent. The saving in coal alone would pay an interest of 5 per cent. on the total cost of the plants installed. The life of the fireboxes must be increased, absence of mud means absence of burned firebox sheets, and any man in close touch with the situation knows that more fireboxes are burned out than are worn out.

You must not think that you can put in an occasional plant here and there and continue the old methods of boiler-washing and get the benefits. If you do, you will be disappointed. Mixing impure water in a boiler with treated water is not a good thing to do, for unless you understand what has been done, the results will lead you to believe that water purification is a delusion and a snare. Neither must you believe your engines will all stop leaking when you have pure water. Other remedies must be applied to overcome bad firing, bad pumping, rapid contraction caused by hurried boiler-washing, running engines from the ash pit to engine-house with fire out and dampers open, and many other abuses that the locomotive is subjected to either by conditions that cannot be overcome or by careless and indifferent men handling them.

Much misdirected effort has been made in the way of using various boiler compounds made on the shotgun or patent medicine principle, but without any attention being paid to the local conditions, the quality or quantity of the water in which they were to be used. Unquestionably, the disappointing results have served to retard intelligent inquiry. Each year larger locomotives are being built with a corresponding increase of water consumption, and the evils from use of impure water must multiply.

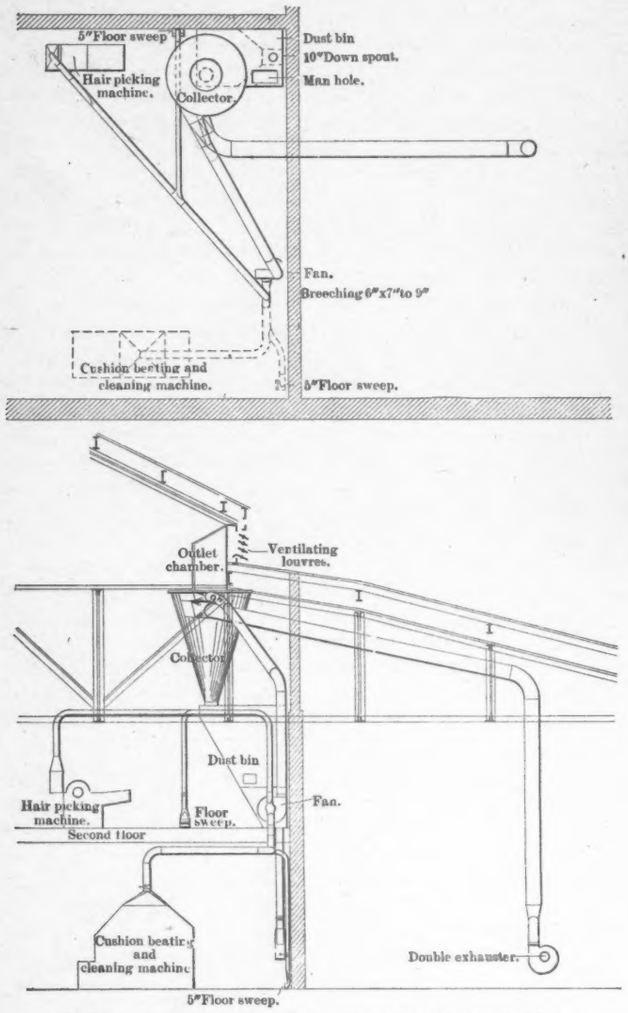
As an illustration of what can be done where nothing but treated water is used, will state that our power-house, containing water-tube boilers of 1,500-h.p. capacity, is using softened water, containing in its natural state 3.9 lbs. of scale-forming solids to each 1,000 gals.; each boiler evaporates on an average 1,000 gals. per hour. These boilers are examined once for each 35 days, and were they using untreated water would contain 3,200 lbs. of scale material at each examination; as it is, however, they are sometimes found to be entirely clean, and then again the lower tubes may have a light film of scale which can easily be washed off.

It is a matter that requires daily intelligent attention, and the results that have been obtained assure us that the opportunities for economies are such as to (if understood) convince any progressive railroad manager that, even though the first cost is large, the returns are so prompt and liberal as to make it unwise to attempt to do without it.

WHY STEEL CAN BE CUT FASTER THAN CAST IRON.—With all the tool steels working on steel at high speeds the continual rubbing of the shaving on the upper surface of the tool wears more or less of a pit on the surface. At the same time, on the extreme point of the tool a small accumulation of portions of the material being cut gathers, being practically welded to the tool. Now, the position of the pit on the upper surface of the tool is situated further back from the cutting edge with a deep cut than with a light one. This is owing to the tenacity of the steel, and is not found to be the case in turning cast iron. The tenacity of the shaving and the action of the tool as a wedge cause the actual point of cleavage to be in advance of the extreme edge of the tool. The larger the chip the greater its strength is, and therefore the further back on the tool it slides, making a greater angle between the shaving and the work wherein the front of the tool is more or less clear. The tool splits off the shaving of material like an axe cleaving wood with the grain. After having once entered, the cutting edge of the axe is clear, while the thicker part of the axe, acting like a wedge, forces the wood apart. In my opinion, the action of the tool in cutting steel is similar, and with the larger cuts the greater part of the work is done well back on the tool, where there is a good body of steel. In a lighter cut the shaving wears a pit right up to the cutting edge, thereby weakening it, and causing it to break down sooner. With cast iron, owing to its brittleness, the action is different, and the work is practically all concentrated on the cutting edge. When the tool first penetrates a piece of iron is broken off for a little distance in advance of the tool; the roughness intervening is removed as the work revolves against the tool, the point of which again penetrates and breaks off a portion, and so the action continues.—*Mr. Arthur B. Corby, before the Salford Science Students' Association.*

PASSENGER CAR REPAIR SHOP.

The arrangement of the passenger car repair shop of the Lake Shore & Michigan Southern Railway at Collinwood is shown on the accompanying drawing. In this shop 80 ft. of the south end is partitioned off and sub-divided to accommodate three important departments, the tin and pipe shop, the brass finishing and lacquering department, and the upholstering department, including the cushion cleaning, dyeing and drying work.

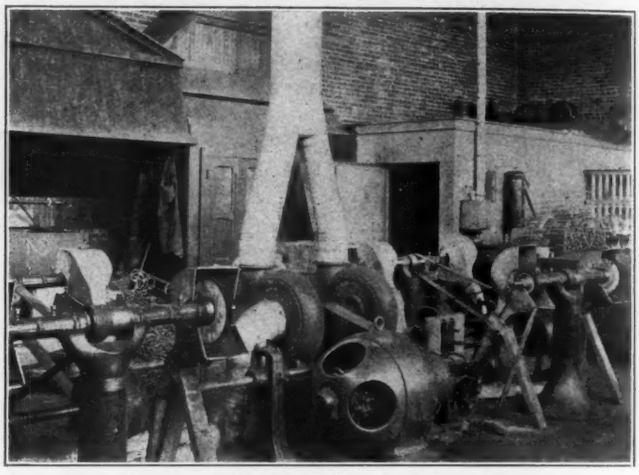


PIPING ARRANGEMENT FOR DUST COLLECTOR SYSTEM.

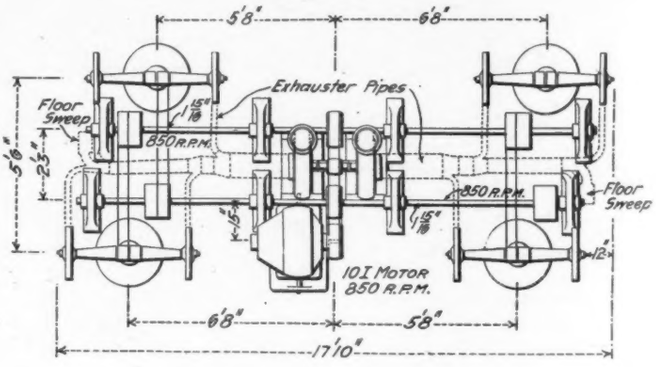
The arrangement of the buffing wheels in the brass finishing room is remarkable not only for its compactness and simplicity, but also for the convenience to the workmen. This is best shown in the detail view and the photograph of the finishing room, presented herewith. There are four two-wheel buffing stands, located 5½ ft. apart between centres of spindles. Between them are arranged the two driving shafts, which turn in opposite directions as is required; these shafts are carried in floor-stand bearings, 18 ins. above the floor. There are two exhausting blowers, used in this group for the purpose of removing the dust and lint from the buffs, which are located at the center of the group, between the two shafts and opposite the motor.

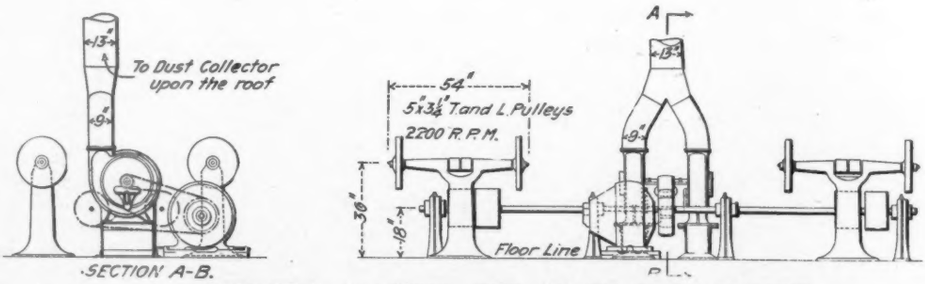
The driving motor, which is a 10-h.p. Crocker-Wheeler direct-current machine, operating at constant-speed of 850 revs. per min., is located in front of the group and drives the two shafts as well as the blower by an interesting arrangement of pulleys so as to use a single belt; this may be understood from the cross section view of the group at A-B. The belt passes over the blower pulley, then wraps back to the nearest shaft pulley, and from there to the further shaft pulley and back. In this way the purpose of the drive is fulfilled—the shafts are operated in opposite directions, and moreover the driven pulleys each have a much larger arc of belt contact than they could otherwise possibly have. This drive works very smoothly and satisfactorily.

The dust collecting system has proved a very efficient and helpful factor in the operation of this department. Each buff



THE BUFFING WHEEL GROUP AND DUST EXHAUSTER IN THE BRASS-FINISHING ROOM. LACQUER CLOSETS AND BAKING OVEN AT THE REAR.





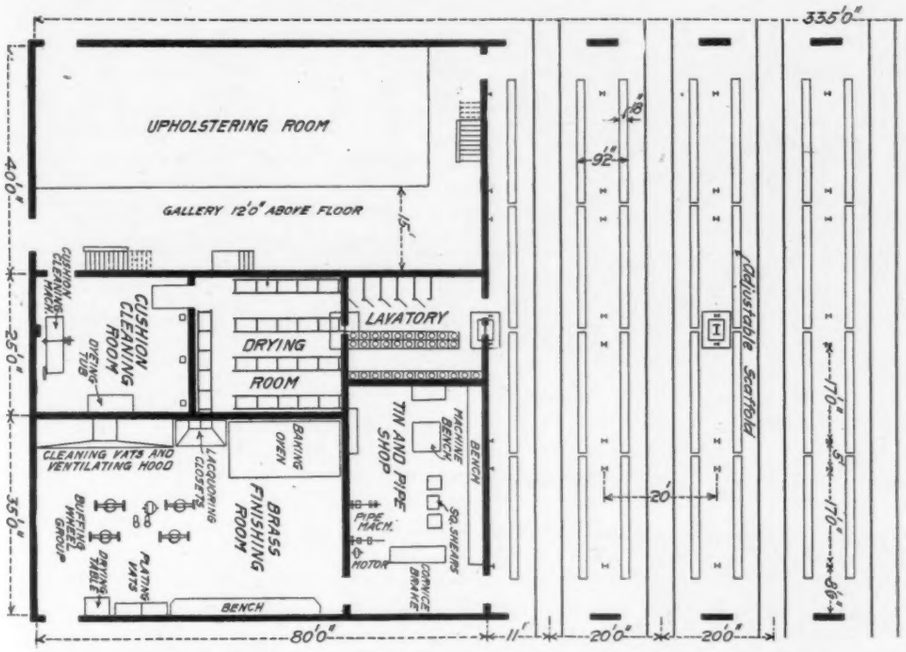
ARRANGEMENT OF BUFFING WHEEL AND EXHAUSTER APPARATUS, SHOWING METHOD OF DRIVING FROM A SINGLE MOTOR.

is constantly served while in operation by an exhaust suction, so that the obnoxious dust from buffing brass is constantly removed from the operator; this not only makes the work much more comfortable for the workmen, but also keeps the room clean at all times. The dust is delivered from the two exhausters up through the roof to a centrifugal dust collector, which also serves the cushion cleaning and hair picking machinery in the next room.

The photograph of the brass finishing equipment is also of

interest in that it shows at the rear the arrangement of ventilating hood over the cleaning and washing vats to carry off the fumes from the acids, etc. Next to this at the right may be seen the lacquering closets, which have special ventilation to protect the workmen from the disagreeable smell of lacquer as far as possible. Beyond in the corner of the room is the baking oven where the freshly lacquered pieces are baked thoroughly by a slow heat; the heat is supplied by steam coils around the walls and the walls are carefully insulated by a special asbestos sheet construction.

The west half of this portion of the passenger car repair shop is occupied by the upholstering department. This consists of a large main work room, 40 ft. by 80 ft., with a gallery extending around its north and east sides, in which the refitting and sewing work upon the cushions is done. Beyond this room to the east is the cleaning room, which contains a cushion whipping and cleaning machine and the apparatus for



DETAIL PLAN OF THE SOUTH END OF THE PASSENGER CAR REPAIR SHOP.

washing, as well as also dyeing, the cushions. The drying room adjoins this to the north. Above the cleaning room is the hair-picking room in which is located the machinery for picking and renovating the hair used for stuffing cushions.

LOCOMOTIVE TEST COMMITTEE.—The advisory committee, representing various scientific and technical interests in the locomotive tests at the St. Louis Exposition, has completed its work and has expressed its appreciation of the action of the Pennsylvania Railroad for the testing plant and all it stands for and specially mentioning Messrs. J. J. Turner, T. N. Ely, F. D. Casanave, A. W. Gibbs, A. S. Vogt, E. D. Nelson and G. L. Wall for their support, co-operation and efficient assistance. This action on the part of the committee is appropriate and pleasing to all those who know the services which have been rendered to the railroad world through these tests.

PRODUCTION IMPROVEMENTS.—There is very little knowledge that can yield larger, immediate dividends than continuous and reliable information about details. Troublesome? Yes. Expensive? Also, yes. But by obtaining and utilizing this information so as to improve both machine and man output, our officials have been able to reduce times over 40 per cent., and to make actual savings anywhere from 35 per cent. to 100 per cent. on all current operations so controlled.—*Mr. Harrington Emerson, Western Railway Club.*

DIES AND FORMERS FOR BULLDOZERS.

There is no questioning the fact that an upsetting machine, or bulldozer, is an essential factor in an up-to-date blacksmith shop. The possibilities of these machines are unlimited; the articles that can be made on them are too numerous to mention. We hear considerable talk about doing work with "one stroke of the machine." I am not so much an advocate of the "one stroke" idea as of the one heat idea. I believe in doing just as much as possible in "one heat." Formers and dies made to complete some articles in one stroke are apt to become so complicated that the cost of making and maintaining would be quite considerable. We make some articles, such as brake mast rests, dead lever guides, ladder steps or grab irons, with two or three strokes of the machine, but always with one heat. The greatest trouble we experience is with the quality of iron furnished by the purchasing department. We never know what kind of iron we have until we come to work it, and you can imagine what we think, yes, even say, when we come to work a lot of hot short iron on the bulldozer. As to the manner of originating these dies and formers, we should never lose sight of the "man behind the gun." The men operating these machines know how and what they can do. I have received some valuable hints from these men, and believe in encouraging these suggestions as much as possible, and when the die is a success don't always say I made this, but, rather, we made this; it costs no more and pays well. As to the quality of the work done on these machines: I met a master blacksmith a day or two after our convention last year who contended that bent hooks on arch bars were better than upset hooks. After returning home I had one of the repair men keep count of arch bars repaired on account of cracked hooks, and the result was that out of twenty-eight hooks twenty-two were bent and six upset. This, I think, is evidence conclusive, and no more need be said on this score. We have recently experimented with chilled cast iron dies for the upsetting machine with very good results, and I believe with a saving to the company. We have entirely eliminated machine work on these dies, using them just as they come from the foundry. There is one article in particular that I might mention, and that is ladder steps or grab irons. The New York Central lines have recently adopted ¾-in. ladder steps as a standard; also the inspector of safety appliances requires grab irons placed on the four corners of all cars. This meant the making of thousands of grab irons, and, naturally, the question of dies and headers became a serious one. Formerly these dies were made of machine steel, and the header of tool steel—the time required to make them being quite considerable. We had patterns made for dies and headers, the chills were finished in our machine shop and furnished the foundry. These castings are obtained for a price of grey iron. No machine work is required, and they give the best of results, being better even than the machine or tool steel formerly used.—*W. J. Mayer, National Railroad Blacksmiths' Association.*

Dull or poorly ground tools restrict the output of a machine, waste power, turn out an inferior grade of work and shorten the life of the machine because of the greater amount of power required.

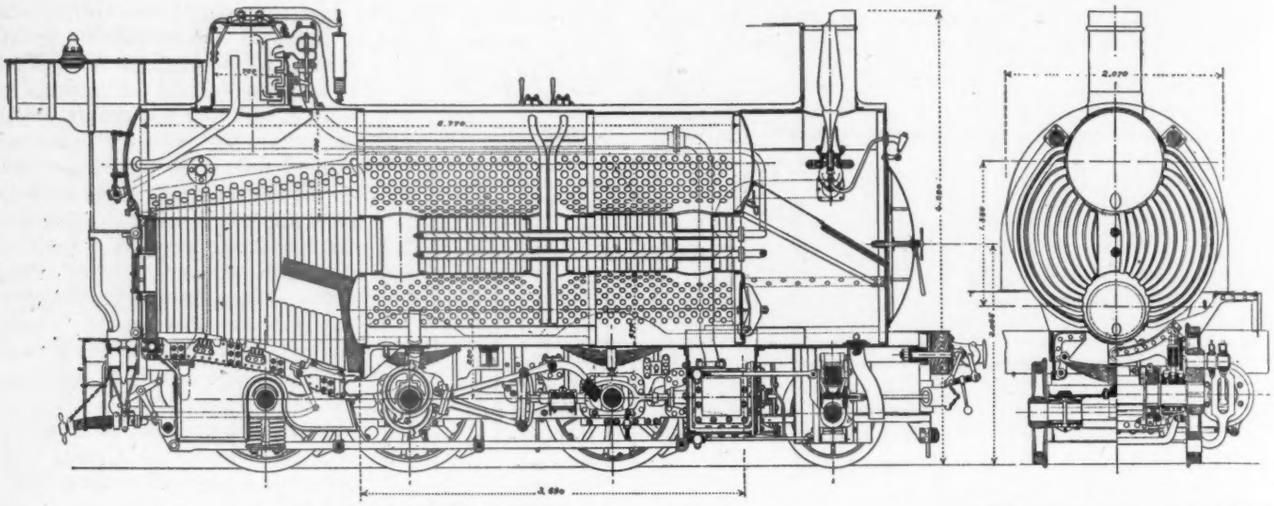
WATER TUBE LOCOMOTIVE BOILER.

PARIS, LYONS AND MEDITERRANEAN RAILWAY.

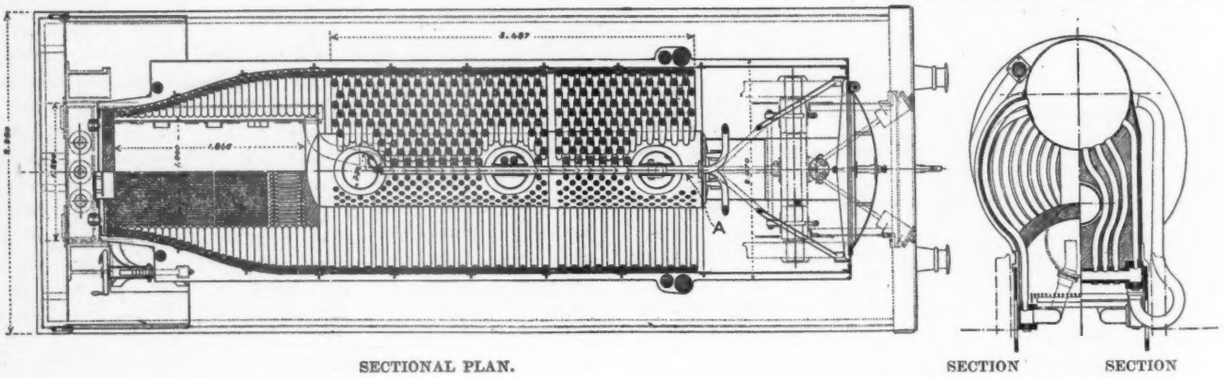
This boiler seems to be successful and it is worthy of record because of an increased interest in water tube boiler possibilities for locomotives. The design is by Mr. J. Robert of the Algerian system of the Paris, Lyons and Mediterranean Railway. There are two horizontal drums, the larger being over the smaller one. These provide water and steam space and they are connected by curved tubes 2.6 in. in diameter, expanded into both drums. Three thimbles connect the two drums as shown in the engraving. From the rear end of the lower drum circulating pipes connect with headers below the level of the grates. These headers are connected with the upper drum by a series of tubes placed close together and forming the inside shell of the firebox, the tubes being covered with a thin steel plate as an outside envelope.

In order to facilitate cleaning the water tubes, two blower pipes extend through the central space and pierce the two forward thimbles which connect the drums. These pipes have many apertures through which jets of steam are blown in inclined directions against the water tubes for the removal of soot and ashes. The valve for these pipes is located in the cab.

When first applied, in February, 1904, the boiler had copper tubes, but these have been replaced by steel. Experience has shown little trouble with mud in the drums, but scale formed in the tubes has required removal by brushes, hammers and tube cleaners on flexible shafts. This boiler is said to steam freely and raise steam rapidly.



LONGITUDINAL SECTION. SECTION AT TRUCK AND BOILER. SECTION AT DRIVING AXLE



SECTIONAL PLAN. SECTION FRONT OF FIREBOX. SECTION BEHIND FIREBOX.

WATER TUBE LOCOMOTIVE BOILER.—PARIS, LYONS & MEDITERRANEAN RAILWAY.

According to a descriptive article by Mr. Sausoll in the *Revue Generale des Chemins de Fer*, from which this description is taken, this boiler was applied to a 2-8-0 freight locomotive, one of a class of which the following table gives the leading characteristics:

	Plain Boiler.	Water Tube.
Cost of boiler itself	$5,000	$4,250
Heating surface, firebox	105 sq. ft.	166 sq. ft.
Heating surface, tubes	1,146 sq. ft.	1,043 sq. ft.
Heating surface, drums	.....	74 sq. ft.
Heating surface, total	1,251 sq. ft.	1,283 sq. ft.
Weight of boiler, full	18.5 tons.	19.3 tons.
Weight of boiler, empty	15 tons.	13.5 tons.
Grate area	19.8 sq. ft.	20.8 sq. ft.
Tubes, number	208	616
Tubes, outside diameter	2 ins.	2.6 ins.
Tubes, length	12 ft.	.....
Capacity of boiler	211 cu. ft.	300 cu. ft.
Volume of water at working level	166 cu. ft.	248.9 cu. ft.

1906 MASTER CAR BUILDERS' AND MASTER MECHANICS' CONVENTION.

Mr. L. B. Sherman, secretary of the Railway Supply Men, announces that the location of the next convention of the Master Car Builders' and Master Mechanics' Associations will be determined by the following gentlemen: Mr. A. E. Mitchell, superintendent of motive power of the Lehigh Valley R. R., S. Bethlehem, Pa.; Mr. G. W. Wildin, mechanical superintendent Erie Railroad, Meadville, Pa., and Mr. F. K. Shults, representing the Supply Mens' Association, whose address is 95 Liberty street, New York. Mr. Shults is chairman of this committee and all communications should be addressed to him in care of the Camel Company, 95 Liberty Street, New York.

ELECTRIC COMMERCIAL WAGONS.—*The Automobile Builder*, of Cleveland, estimates that the number of electric commercial wagons now in actual service in this country can be conservatively placed at four thousand.

OPERATION OF THE McKEES ROCKS SHOPS' POWER PLANT.

A few points in connection with the compact and efficient power plant for the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad may be of interest. This plant is thoroughly up to date in almost every respect. It embodies a great many of the best features in power plant design. The building is 77 x 100 x 50 ft. high from the basement floor. Most of the pumps are in the basement. The main floor is divided by a brick partition wall into engine room and boiler room. The boilers are six Babcock & Wilcox 264 h.p. each, nominal rating. They are, however, worked much above this rating. A load of 1,800 b.h.p. has been carried for several hours on four boilers. It was calculated that five boilers would at any time be sufficient to take care of the load, leaving one for spare. In connection with these boilers, I may say that we had a great amount of trouble at first from burning out tubes, 56 tubes requiring to be replaced in three months. When the water softening plant was installed and in good working order the trouble ceased, and now the tubes remain almost as clean as the day they were installed. The coal and ashes are handled by machinery, the coal is dumped from hopper cars through a grating to a hopper beneath, whence it is hoisted by endless chain or conveyor to top of building; it is there dumped on a horizontal conveyor, which deposits it at points desired in the storage bins, when it flows by gravity to stoker hopper. The ashes are handled from the basement by the same machinery and are dumped into a storage bin directly over the track, thence into hopper cars beneath. Coal capacity is 200 tons; ash capacity, 2,000 cu. ft. The engines installed are four 14 x 24 x 14 Westinghouse compound engines, 280 r.p.m., about 250 h.p. Generators are of the direct connected Westinghouse, 150 k.w. capacity, 240 volts. The switchboard is an 18 panel board, consisting of four generator panels, one load panel, five incandescent light and constant speed motor panels, three arc light panels and five variable speed motor panels. There are fifteen pumps, which cover every purpose and are of various capacities, from a 50-gal. test pressure pump to a 1,000-gal. cold water supply pump. Five of the pumps are motor driven centrifugal or turbine pumps.

The two air compressors are each capable of compressing 1,000 cu. ft. of free air per minute to 100 lbs. pressure. There are also what are termed balancers or motor generators to split the 240-volt circuit into two 120-volt circuits for the arc lighting and six voltages from 40 to 240 for the variable speed motors.

The power plant takes care of the heating of the whole system of buildings, some of the buildings being half a mile from the power house. The heating is performed by circulating hot water through large heating coils in the various buildings, from which the heat is extracted by the air forced over them by fans. The temperature in all the buildings is controlled in the power house by raising or lowering the temperature of the water, which can be done at will. The water is heated in the power house in large heaters by means of exhaust steam supplemented by live steam, and is circulated through the system by two centrifugal pumps. It is expected that the heating load in 10-deg. weather will, when all the buildings are up, be about 40,000,000 b.t.u. per hour, 40 per cent. of this being taken care of by the exhaust steam. The steam pressure carried is 150 lbs., voltage 250 volts d.c., water pressure, general service, 80 lbs.; fire service, 100 lbs.; hot water supply, 125 lbs.; test pressure, anything up to 400 lbs. About 4,000,000 gals. of water are used per week, and as 95 per cent. of this is double pumped, the pumps handle about 8,000,000 gals. a week.

The force at the power house consists of a superintendent who has charge of the men on three tricks, each trick consisting of one engineer, one oiler and one fireman; in addition, there are during the daytime two extra helpers. This is a very small force of men, and the good results can only be accomplished on account of the large number of labor-saving devices installed and the care and forethought expended on the original design. The plant is not yet worked to the limit, as several new buildings have yet to go up, but from present appearances it would seem that it will accomplish what it was designed for. The plant is sometimes criticised on account of the small electric units used, but the load varies very greatly. On summer nights one generator is sufficient to carry the load, while on dark days in winter all four generators are in service.

In proportioning the cost everything is based pro rata on the actual steam consumption, the steam consumption in most cases being based on result of tests. An extract from the 1904 yearly report is as follows:

PITTSBURGH & LAKE ERIE RAILROAD COMPANY, McKEES ROCKS POWER PLANT.

	Total.	Monthly Average.
Steam Pressure, Pounds		148.3
Coal Consumption:		
Cars, total	265	22.08
Pounds, total	22,724,400	1,893,700
Pounds per hour		2,592.1
Ashes, cars loaded	42	3.5*
Water Evaporated:		
Gallons, total	20,910,000	1,742,500
Pounds per hour		19,373.2
Pounds per hour per lbs. of coal:		
Actual		7.475
From and at 212 deg.		8.662
Boiler h.-p. developed		645.8

*Ashes were 13 per cent. by weight of the coal.

EXPENSES.

			Per Cent.
Wages	$10,274.95	$856.25	50.27
Supplies	1,861.43	155.11	9.11
Machine Repairs	1,483.54	123.63	7.26
Coal	6,817.62	568.14	33.36
Total	$20,437.54	$1,703.13	100.00

GENERAL DISTRIBUTION.

Heating	$3,208.01	$267.34	17.00
Compressed Air	5,464.66	455.39	26.31
Lighting	2,255.20	187.93	11.10
Pumping	4,779.69	398.31	22.78
Machine Tools, etc.	3,602.66	300.22	17.32
Locomotive Filling	1,127.32	93.94	5.49
Total	$20,437.54	$1,703.13	100.00

RATES.

Cost in cents, per	Maintenance.	*Total.
B. H. P. Hour, developed	0.367	0.752
K. W. Hour	0.628	1.286
H. P. Hour, electric	0.469	.962
1,000 Cu. Ft. free air, comp.	1.695	3.474

*Based on cost of plant of $165,000, 5 per cent. interest and 8 per cent. depreciation.

[EDITOR'S NOTE.—A detailed description of the power plant will be found in the May, 1904, issue of this journal, page 169. The above article is taken from a paper read before the Engineers' Society of Western Pennsylvania by Mr. G. M. Campbell, electrical engineer of the Pittsburgh & Lake Erie Railroad.]

In passing through a large railroad shop one day during the recent hot spell the writer noticed a unique advantage which was being taken of an individual motor-driven machine tool. The motor was mounted above the headstock of a Jones & Lamson turret lathe, and the machine operator had fastened a small fan to the end of the armature shaft, so that a cool breeze was directed upon him while the machine was in operation.

VACATIONS.—"The summer vacation is one of the most useful of business customs," declared an employer. "By means of vacations the employer gets a line on his men. For instance, Mr. A is away two weeks and his work is done by young B, who accomplishes more and makes suggestions that are worth following. That means that A's department is going to turn out more work from that time on. Then perhaps old C takes a month and leaves his assistant in charge. If things go to pieces it means that C needs a new assistant or that C is selfish about developing a possible successor. In any case we have learned something mighty interesting and useful."—*N. Y. Sun.*

FIG. 2—TRAVELING TROLLEY RUNNING OFF THE TRANSFER BRIDGE ON TO ONE OF THE SPUR TRACKS.

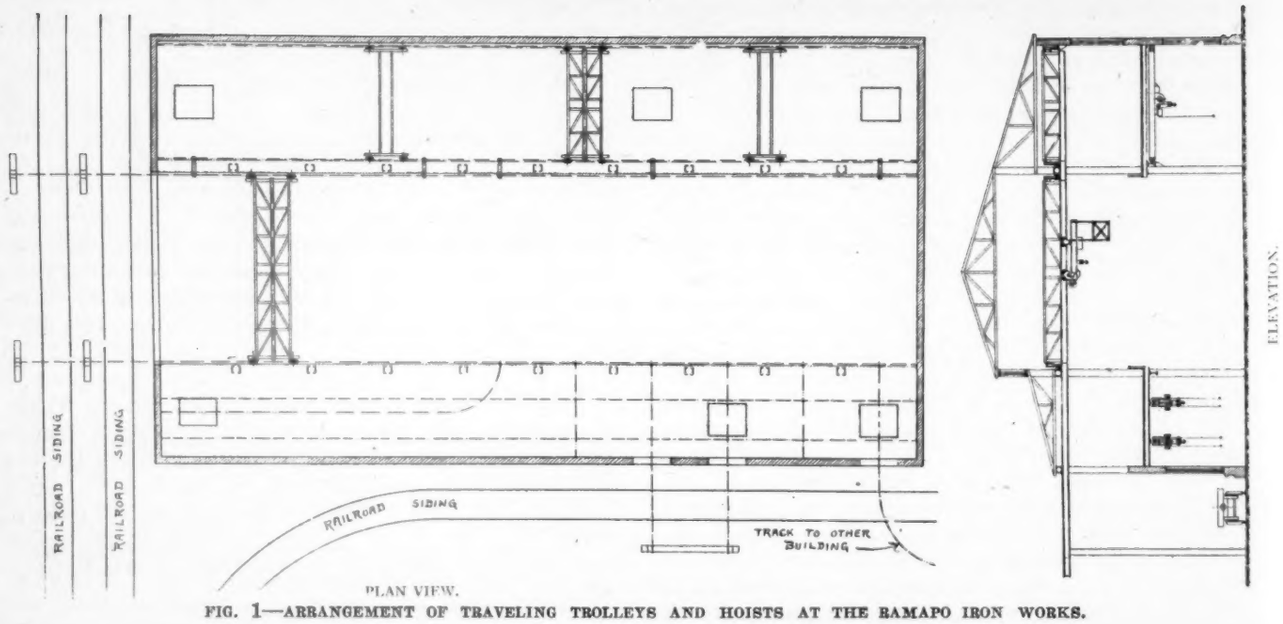


FIG. 1—ARRANGEMENT OF TRAVELING TROLLEYS AND HOISTS AT THE RAMAPO IRON WORKS.

ELECTRIC TRAVELING HOISTS.

An inexpensive system of traveling cranes for handling loads from 1½ to 5 tons, and which is admirably adapted for use in railroad storehouses and scrap yards, has been installed at the Ramapo Iron Works, Niagara Falls, N. Y. The trolleys and hoists run on the lower flanges of a single I beam, and it is thus possible to install this arrangement in places where it would be impossible to arrange for regular crane runways, and it is very much less expensive. The traveling trolleys may be run off the transfer bridge on to the single I beam tracks, which may be arranged in almost an endless variety of ways, making it possible to carry the load to any point in an extensive plant. As an illustration, the diagram in Fig. 1 shows some of the combinations which are used at the Ramapo Iron Works. The transfer bridge operates over the middle bay of the shop, running out at one end over the two railroad sidings. The trolley on this traveling crane may be run off on to another crane in the gallery to the right of the main bay in the cross sectional elevation, or it may be run on to the spur tracks in the gallery to the left. One of these spur tracks runs to another building; two of them extend out over the rail-

road siding; two others extend over the gallery and one curves around and runs lengthwise of the gallery.

Fig. 2 shows the traveling trolley as it is about to leave the transfer crane to run onto one of the spur tracks. The cage for the operator is attached to the trolley, so that the operator is always with the load. In transferring the trolley it is only necessary to move the transfer table in line with any one of the spur tracks. An independent motor drive through a train of gearing is used for traversing the trolley along the track and only two conductor wires are required for each spur track. The trolley may be provided with swivel trucks to allow it to run around curves of from 12 to 20 ft. radius. When the transfer bridge is used it is operated by a separate motor, controlled from the operator's cage on the trolley. A set of stops is provided for the transfer bridge and spur tracks, so as to prevent the trolley from running off the track.

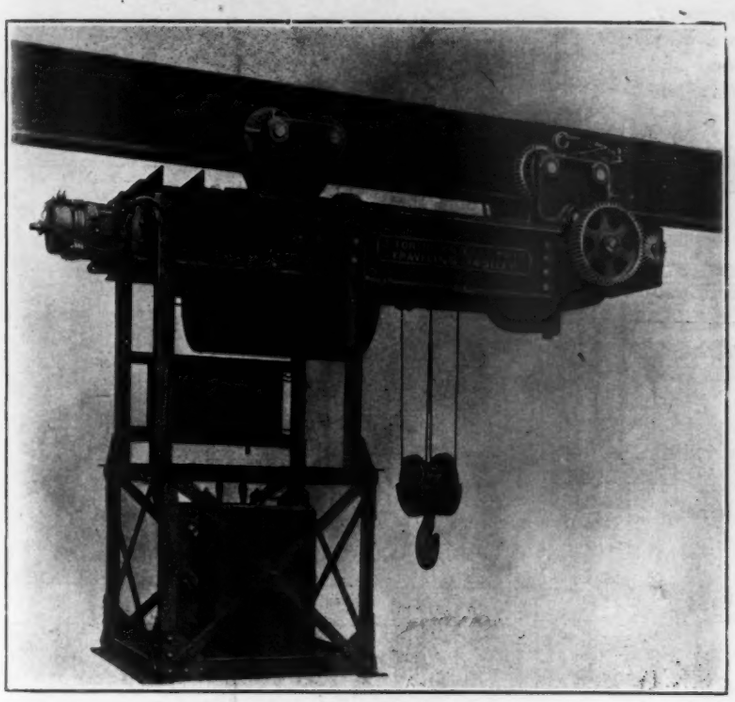


FIG. 3—NILES ELECTRIC TRAVELING TROLLEY.

If the nature of the plant is such that the traveling crane, which, in this instance, acts as a transfer table, is not required, it would be very easy to arrange a series of the I-beam tracks, which could be connected by switches, and it would thus be possible to arrange to transfer loads from one part of a plant to the other. Such a system could readily be extended from time to time to meet the growing demands, and could readily be adopted for almost any purpose. These traveling hoists and trolleys are made by the Niles-Bement-Pond Company, 111 Broadway, New York.

CONDENSING VERSUS NON-CONDENSING PLANTS.—It is generally assumed that a low water rate condensing plant is more economical than a non-condensing one where the rate is higher, but such is not always the case. If all the heat in the exhaust steam can be made use of, then relatively inefficient but low cost engines would, when interest and depreciation as well as the coal pile are considered, be the cheapest to install and maintain. If steam from the boiler is eventually discarded as water and at the same time the feed water enters the boiler at or near 212 degs., what more could be desired or obtained? I have in mind a non-condensing plant of 2,000 b.h.p., which in winter uses every ounce of exhaust steam and in summer a very large percentage of it. That plant is working very economically, though the engines and pumps installed have a high water rate.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

STARTING A STEAM TURBINE.

In his recent paper before the American Society of Mechanical Engineers Mr. A. S. Mann described the starting of turbines in a power station as follows:

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air pump are started by the oiler. These movements take place simultaneously. The force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after performing it looks to see that there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine.

The turbine throttle is opened as fast as an 8-in. steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit, but if nothing unusual occurs in the pipe line sentiment does not spare the turbine.

One electrician attends to the switchboard and telephone. As soon as the machine approaches speed the synchronizing system is cut in and the main switches are got ready. One and one-half minutes will do all the work here outlined, including the considerable time taken in mustering the crew from various parts of the building.

Manipulating an engine regulator so that it shall be at a precise speed and at an exact phase relationship from some other machine, not more than 1-1500th part of a second removed from it, is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in 2½ minutes, including full load on the turbine, which starts from a standstill.

This performance has been gone through a great many times, and our record book shows that out of 43 such calls 10 starts were made in 2½ minutes, 18 in 3 minutes and 15 in 3½ minutes. We have taken the time in a number of instances when all the auxiliaries have been in motion and it only remained to start the turbine and phase it in on the line; the only valves to open in such cases are the throttle and one small oil valve. The two quickest starts have been made in 45 seconds and 70 seconds, respectively, including phasing-in. Others range between 1 minute 10 seconds and 1½ minutes. These two quickest starts were made on a turbine which had stood for 24 hours with the throttle valve shut tight, though there was a slight leakage past the seat. After the throttle valve is off its seat it is not more than 30 seconds before the turbine is up to speed. A cross compound reciprocating engine of the four-valve type, 2,250 h.p. capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the seventy seconds required for the similar turbine operation.

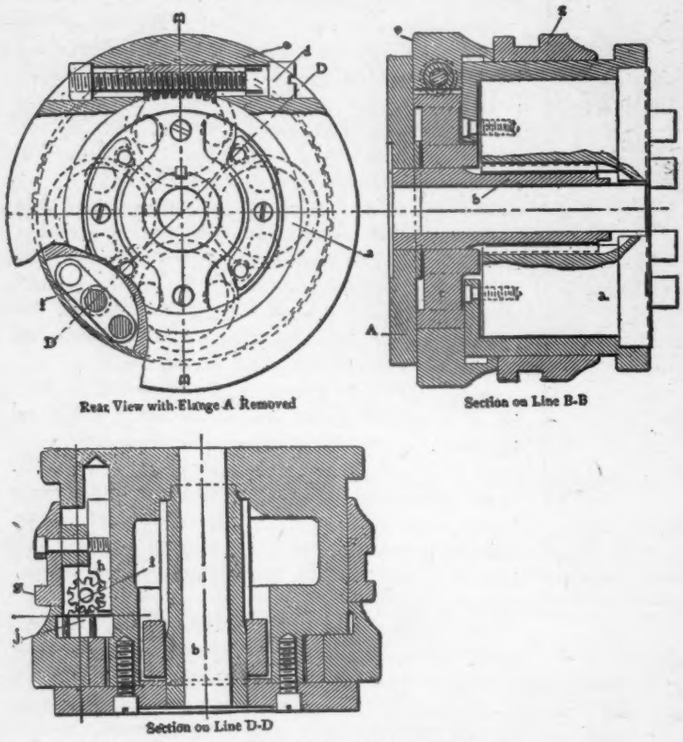
A reciprocating engine, which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated, can be brought up to speed, say 75 turns, in 2½ minutes. This can be compared with the 30 seconds necessary for bringing the turbine up under the same conditions; that is, about one-fifth the time necessary for bringing up the engine.

If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, 15 minutes is called a rapid

start. Starts have been made under such conditions in 12 minutes. When we start a cold turbine we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed, and she will be at speed in 2½ minutes, dividing the engine's time by more than four.

LANDIS BOLT CUTTER HEAD AND CHASERS.

The Landis bolt cutter head and chasers, shown in detail in the accompanying illustrations, have several notable features which makes it possible to increase the capacity of a bolt cutter, at the same time reducing the cost of maintenance of the dies. The die is composed of four chasers, as shown in Fig. 1, which are made from flat pieces of steel with the threads which form the teeth milled their entire length. The chasers may be sharpened by a simple grinding operation, and no annealing, hobbing and retempering is necessary. They may be repeatedly sharpened until reduced to a very short length. The chasers are beveled at the front edge, and the throat thus preserves a uniform shape after grinding, and

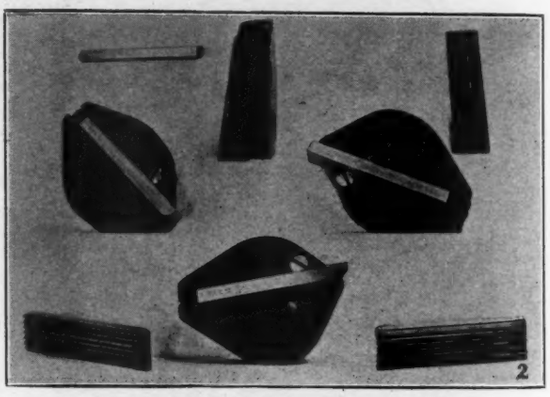


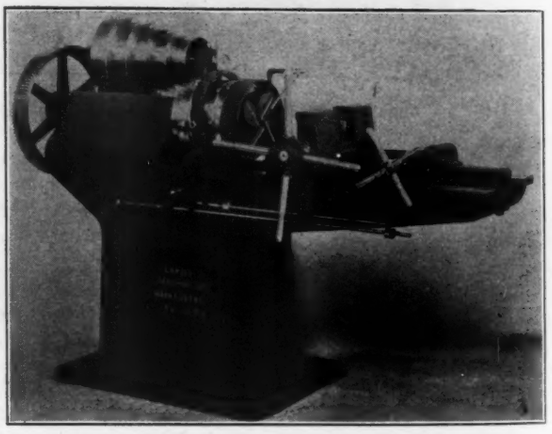
DETAIL CONSTRUCTION OF LANDIS DIE HEAD.

it is at all times possible to cut close to the head of the bolts. Each chaser is held in a grooved block, and these blocks are carried by four oscillating spindles, which are geared together in the head, and are made to operate simultaneously to open and close the die and to adjust it to the proper size. A screw with a circumferentially grooved head holds the chaser in place by engaging the threads, clamping it rigidly. An adjusting screw at the other end of the block forces the chaser downward until the piece becomes too small to hold. In grinding the chasers the holder is set on a gauge, which may be used in connection with any ordinary cutter grinder.

The cutting is at all times done by the front teeth, while the back teeth do no cutting, but take a bearing on the work a little back of the face of the chasers, thus forming a permanent hardened lead nut, whose bearing surface is renewed each time the chaser is ground. The clearance in the die admits of the highest possible cutting speed. After grinding, the chasers are set to the proper position in the holders by means of a gauge. They are set on lines tangent to the bolt and at an angle to agree with the pitch of the thread. This die head may readily be attached to bolt cutters other than the Landis. The head has no wearing surfaces exposed to chips and scale, and the bearings are so arranged that any wear which may take place will not affect the efficiency of the die.

The construction of the die head is shown in Fig. 4. The four oscillating spindles, *a*, each have two pins upon which the chaser blocks are slipped. At *b* is a central pinion bored out to allow the work to pass through and engaging with a short series of teeth formed on each spindle *a*. Near the rear end of the pinion is fastened a disk, *c*, which is engaged at its periphery by a rack adjusted by screw *d* to set the die to





1. BOLT CUTTER HEAD SHOWING ONE HOLDER AND CHASER REMOVED. 2. CHASERS AND HOLDERS. 3. DIE HEAD APPLIED TO LANDIS BOLT CUTTER.

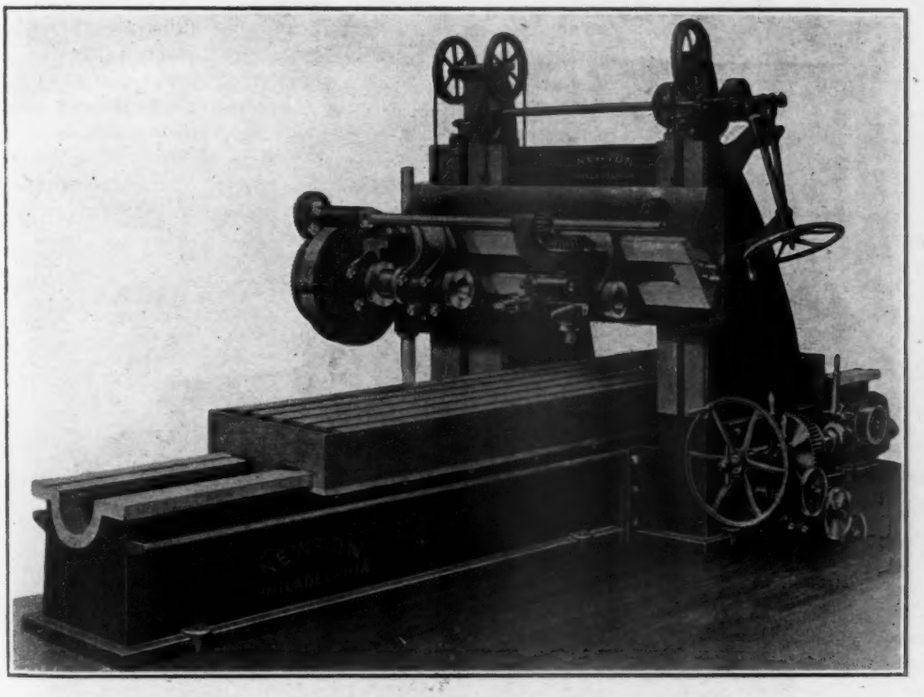
proper size. The rack is seated in a ring, *e*, encircling the head; and this ring, through toggle links, *f* (connected at one end to *e* and at the other to the body of the device), is given a limited oscillating movement to operate pinion, *b*, and so open or close the chasers. The toggle is operated by ring, *g*, which is moved back and forth by lever and yoke, shown in Fig. 3, this ring being attached to a rack, *h*, meshing with a pinion, *i*, which also meshes with rack teeth formed on the head of toggle connection, *j*. With ring *g* thrown back the toggle pin is lifted to the position shown, the links are thrown out straight as at *f*, and the chasers are positively locked in cutting position. When ring *g* is slid forward again the toggle draws the chasers open. The pins upon which the toggle

links are mounted are so arranged that through openings in the rear plate the pin in ring *c* may be slid into a seat in the head proper, and the other pin drawn into a seat in the ring, thus reversing the action of the ring and giving the chaser block trunnions the right movement for left-hand chasers.

A chuck for holding nut taps is composed of four holders, which may be substituted in place of the chaser holders. This chuck may be opened and closed the same as the one for the die. This device is made by the Landis Machine Company, Waynesboro, Pa.

PLANER TYPE MILLING MACHINE WITH AUXILIARY VERTICAL SPINDLE.

The planer type milling machine, illustrated herewith, is adapted for heavy work, such as the milling of locomotive side rods, rod brasses, driving boxes, shoes and wedges, and cross-heads, and is equipped with an auxiliary vertical spindle, which in no way interferes with the horizontal spindle, and may be used to advantage on such work as milling key-ways and for finishing the front section of locomotive frames. The cross rail is counterweighted and has an inclined face, and this design, in connection with the extra heavy and rigid uprights, overcomes to a very great extent the tendency to chatter, and also of dropping in when running from a wide to a narrow section. The table is operated by means of a spiral pinion and rack, and has a wide range of feeds, variable through friction discs, and also has a power quick traverse in either direction.



PLANER TYPE MILLING MACHINE WITH AUXILIARY VERTICAL SPINDLE.

The carriage is 36 ins. wide and 12 ft. long, and the uprights will admit work 40 ins. wide. The maximum distance from the center of the horizontal spindle to the table is 30 ins. The horizontal spindle is 6 ins. in diameter, and has an in-and-out adjustment of 6 ins. on the cross rail for convenience in setting the cutters. The auxiliary vertical spindle is designed and constructed as a part of the outboard bearing of the horizontal spindle which carries the cutters. The horizontal spindle which drives the vertical spindle is 3 ins. in diameter. The vertical spindle has an independent vertical adjustment of 2 ins. with a micrometer and is adjustable across the rail the full width of the table, and where desired will be furnished with an automatic cross feed. This machine is made by the Newton Machine Tool Works, Philadelphia, Pa.

THE SHEARING STRENGTH OF RIVETS.

The following report on the shearing strength of rivets was presented at the Master Steam Boiler Makers' Convention at Chicago, and the conclusions of the committee are such as to warrant a careful study of the report by those interested in this subject:

On beginning our tests a number of pieces were prepared according to rules and formulas approved by mechanical engineers and which are in use at the present time by many, if not all, of the prominent builders. While a number of the joints showed an efficiency above that rated for them, we found that invariably they showed a weakness at the edges of the plate, tearing out from the edge of hole to the edge of plate, so that from these pieces it was impossible to determine the actual shearing strength of the rivet. We at first concluded we had made an error in preparing the plates. However, on checking up our work we found conditions as follows: A standard rule in practice, accepted generally by the builders, is as follows: For distance from center of rivet hole to edge of plate, take D × 1.5, which, in our case, would be diameter of hole, 13-16 in. × 1.5 = 1.21 ins. This we increased slightly, making the lap 1¼ ins., and to further insure the shearing of the rivet we used ½-in. plate with ¾-in. rivets in 13-16-in. holes, and out of eight pieces tested with the rivets in double shear (four with iron and four with steel rivets) each one of them fractured at the edge of the plate.

We next prepared four pieces with rivets in double shear, two having iron and two steel rivets, one hand and one machine riveted, and instead of using the constant 1.5 we used 2. On testing the first piece, using iron rivets in double shear, the result was: Shearing strength of one rivet, 42,240 lbs.; shearing strength per sq. in., 81,481 lbs., hole elongated and end of plate distorted, 0.16-in. The next test resulted as follows: Iron rivet in double shear — shearing strength of one rivet, 40,920 lbs.; shearing strength per sq. in., 78,934 lbs.; hole elongated and end of plate distorted, about the same as first test.

We next tested a piece prepared the same as the two previous tests, except with steel rivets in double shear, which resulted as follows: Shearing strength of one rivet, 46,575 lbs.; shearing strength per sq. in., 89,843 lbs. In this case the hole was elongated and end of plate distorted 0.34 in. The next test with steel rivet in double shear resulted as follows: Shearing strength of one rivet, 43,805 lbs.; shearing strength per sq. in., 84,500 lbs.; hole elongated and end of plate distorted, 0.29 in.

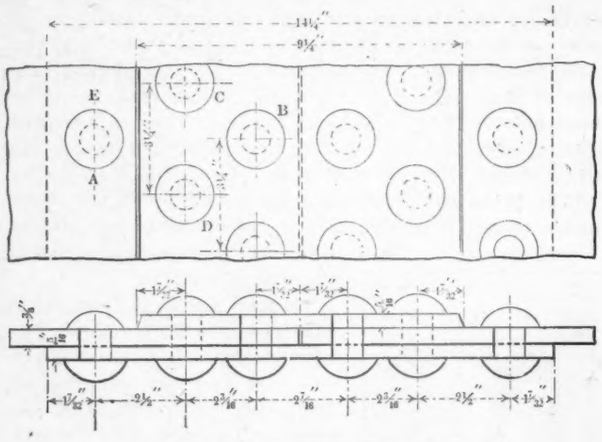
The rivets tested in single shear resulted as follows: 1. Test iron rivet—shearing strength of one rivet, 22,190 lbs.; shearing strength per sq. in., 42,824 lbs. 2. Test iron rivet—shearing strength of one rivet, 20,840 lbs.; shearing strength per sq. in., 39,409 lbs. 3. Test steel rivet—shearing strength of one rivet, 25,840 lbs.; shearing strength per sq. in., 49,845 lbs. 4. Test steel rivet—shearing strength of one rivet, 25,840 lbs.; shearing strength per sq. in., 49,845 lbs. It will be noticed that the steel rivets in single shear showed exactly the same results.

Following is a table showing the kind of rivets, diameter and area of hole, shearing strength of one rivet, shearing strength per sq. in. and increase in percentage for double over

single shear. From this it will be noted that the increase for double over single shear averages considerably higher in iron rivets than it does in steel rivets; also that the increase is greater for machine driven rivets than for hand driven, this being attributed to the frictional resistance of the plates, which is not so effective in the hand work:

No. of test.	Kind.	Shear.	Diameter. Inch.	Area. Inch.	One rivet. Pounds.	Per square inch. Pounds.	Increase double over single. Per cent.	
1	Iron	Single	13-16	0.5184	22,190	42,824	...	Hand
2	Iron	Double	13-16	0.5184	42,240	81,481	90	driven.
3	Iron	Single	13-16	0.5184	20,430	39,409	...	Machine
4	Iron	Double	13-16	0.5184	40,920	78,934	104	driven.
5	Steel	Single	13-16	0.5184	25,840	49,845	...	Machine
6	Steel	Double	13-16	0.5184	46,575	89,843	80	driven.
7	Steel	Single	13-16	0.5184	25,840	49,845	...	Hand
8	Steel	Double	13-16	0.5184	43,805	84,500	69	driven.

We next prepared a triple riveted butt strap joint, using ⅜-in. plates with ¾-in. rivets (iron) in 13-16-in. drilled holes,



TRIPLE RIVETED BUTT STRAP JOINT.

as shown in the illustration herewith. This joint has a rated efficiency of 87.5 per cent. Using a section of 6½-in. wide plate, ⅜-in. thick, steel of 58,500 lbs. test strength, the strength of the solid plate should be 0.375 × 6.5 × 58,500, which equals 142,593 lbs.; 87.5 per cent. of this would be 115,145 lbs. By actual test this joint developed a strength of 115,120 lbs., or only 25 lbs. less than the calculated strength. Now, assuming that each rivet in this joint would sustain as great a load as in test No. 2 in the table, the shearing strength of the rivets in the section tested would be 42,240 lbs. × 3 (number of rivets in double shear) plus 22,190 lbs. (one rivet in single shear), or 148,910 lbs., or 22 per cent. stronger than the ultimate strength of the section tested. Next taking the net section at A, on the illustration, we have 6½ ins., or 104-16 — 13-16 = 91-16, which, divided by 104, the original or solid plate, gives 87.5, or the rated efficiency of the joint. However, our test showed the net section not to be the weakest point, but the fracture occurred first at B, tearing out from the hole to the edge of the plate at the first row, the same as in the first tests, and next shearing off rivets C, D and E. Now, as neither the ultimate strength of the net section nor the shearing strength of the rivets was actually reached when rupture occurred, it will be evident to all that this joint can be made considerably stronger by adding to the distance from the center of the hole to the edge of the plate, or, in other words, using 2 as a constant instead of 1.5 in calculations for rivets in double shear, as we found necessary to do in our tests previously described to ascertain the shearing strength of the rivets.

The shearing strength of rivets we find to be about as follows:

For riveted plates:	Pounds.
Iron rivets, single shear, average per square inch	40,000
Iron rivets, double shear, average per square inch	78,000
Steel rivets, single shear, average per square inch	49,000
Steel rivets, double shear, average per square inch	84,000

In addition we wish to invite your attention to the following points of interest:

1. The noticeably greater increase for iron rivets in double shear over their single shearing strength, as compared to steel rivets in double shear over their single shearing strength.

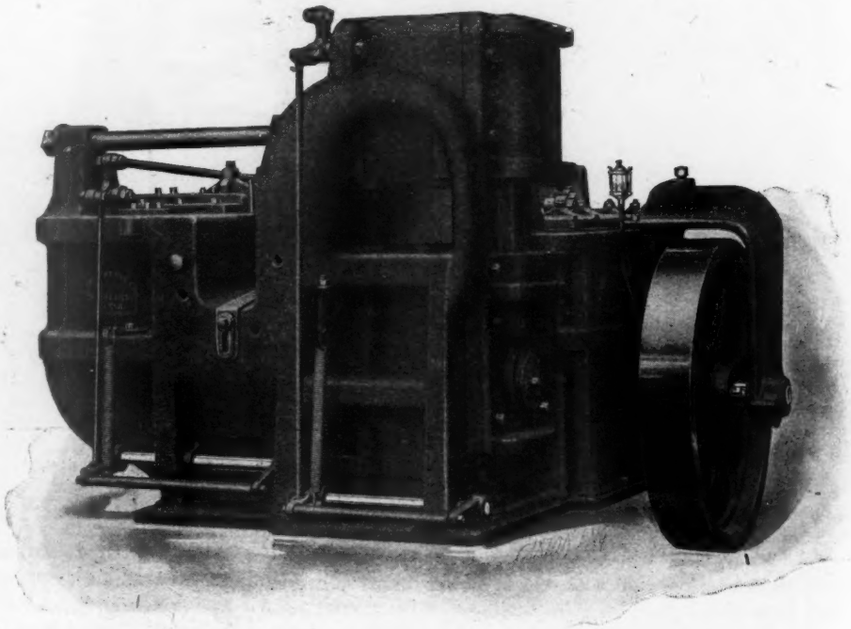
2. The greater increase for machine driven rivets in double shear over hand driven rivets; hand driven not to be hammered after getting cool.

3. The apparent necessity for deciding on a new constant in place of 1.5 for calculating the distance from center of holes to edge of plate for rivets in double shear at first row of holes.

In closing the committee wishes to extend its thanks to O. K. Harlan, assistant mechanical engineer, Delaware, Lackawanna & Western Railroad, and J. G. Platt, engineer of tests, Erie Railroad, for the assistance rendered in making the above tests.

UNIVERSAL FORGING MACHINE.

The Ajax universal forging machine, illustrated herewith, marks a new departure in forging machinery, as by its use forgings can be made at a considerably lower cost than formerly, due to the saving of heats and handling, and many intricate forgings can readily be made which it has been impossible to make on other forging machines. It retains all the features of the well-known Ajax heading, upsetting and forging machine and in addition has a powerful vertical



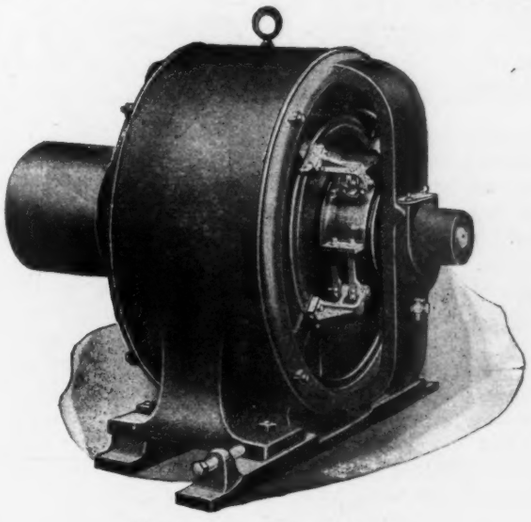
UNIVERSAL FORGING MACHINE—AJAX MANUFACTURING COMPANY.

press which may be used for forging, bending and trimming. This press has a vertical movement of from 3 to 5 ins., according to the size of the machine. A screw adjustment to the stroke of the head, readily accessible from all parts of the machine, enables the operator, when setting the dies, to bring them to the exact point desired.

The vertical movement of the head is obtained by heavy links, connected at the lower end with levers, on which are eccentric hubs which give the head the desired throw or stroke. These levers in turn are connected to a slide, placed

horizontally and actuated by an eccentric shaft in the back end of the machine. This mechanism is entirely separate and independent of that which operates the forging machine, although both are in the one bed. The forging press is brought into operation by the operator depressing the pedal on the right of the machine. This allows the lock, between the eccentric shaft and header slide, to drop into place. The operator can give one or more blows as desired. On taking the foot off the pedal the lock is released automatically and the forging press comes to a stop with the dies wide open. The locking device is an exact reproduction of the well-known Ajax lock, so successfully used on the Ajax heading, upsetting and forging machine.

The design of the bed is of box form, cast solid in one piece and made of a special mixture of strong, close-grained iron and of ample strength to withstand the excessive stresses incident to the operation of this class of machinery. These machines are built in seven sizes, known as A, B, C, D, E, F and G. The weight of the machines varies from 18,000 lbs. for the A size, to 180,000 lbs. for the G size. They are built by the Ajax Manufacturing Company, of Cleveland, Ohio, and are the invention of Mr. J. R. Blakeslee, Jr., general manager of the company.



20-H.P. STEEL FRAME MOTOR.

FRAME SHOWING ARMATURE IN POSITION.

STEEL FRAME MULTIPOLAR MOTORS.

The new steel frame motors made by the Triumph Electric Company, of Cincinnati, are notable for their light weight, high efficiency, good wearing qualities, accessibility of all parts, and their ability to stand heavy overloads and sudden fluctuations of load. The frame is made of close-grained steel, and its compact form and comparatively light weight greatly simplifies the problem where it is desired to mount the motor directly upon a machine tool. A special flexible idler, which increases the belt surface on the pulley and overcomes the slackness of the belt, makes it possible to use a belt drive with very close centers. The brackets are bolted to the frame, but may readily be removed if necessary. The construction is such that the motor may be mounted on the floor, wall or ceiling. The poles are of steel, and equipped with a special design of laminated tip or shoe, which adds considerably to the efficiency of the machine. The bearings are self-oiling and self-aligning. An oil guard on the armature and an improved method of carrying the brush yoke on the crown, instead of upon the pedestal, prevents the oil from getting into the armature, commutator or brush rigging, and thus causing short circuits.

The armature is of the iron clad, laminated core, tooth type, and is thoroughly insulated. The armature coils are form wound, and each consists of a continuous length of copper, with no joint except where connected to the commutator. The commutator bars are of hard-drawn copper, of extra depth, and are mounted upon a cast steel shell, so constructed that they cannot move and the commutator cannot get out of true. The field coils may be either shunt, series or compound wound, according to requirements. During construction and after being placed in the machine each coil is tested with 2,000 volts alternating current. The brush holders are of simple design, and are constructed with a view to the sparkless operation of the brushes, freedom from noise and minimum heating and wearing of the commutator. An interesting application of one of these motors to a traverse grinder, made by the Cincinnati Shaper Company, is illustrated on another page of this issue.

Wm. Sellers as a Designer of Machinery.—William Sellers had certain well-defined ideas. Beauty of line and grace of form were insisted on, and he early adopted, if he did not invent, the dull lead tint now known as "machine gray," which has now almost entirely supplanted the reds and greens and blacks of the early builders. Fitness for the purpose intended, as he saw it, was the keynote, and he had as much horror of unnecessary weight as he had of any other defect in proportion. In construction nothing suited him but the best. He was never deterred by consideration of cost if he saw a way of improving in design or construction. Absolute honesty of purpose was his dominant characteristic, and he would tolerate no deviation from the standard of workmanship, no matter how tempting might be the occasion. There was no thought of patching defects in workmanship or material. Nothing was "good enough" unless it was perfect. Jealous of his reputation, he set a high standard and followed it undeviatingly. He had to a wonderful degree the courage of conviction and would follow out his own conclusions without hesitation in the face of adverse opinion. In fact, opinions had very little weight with him in professional matters, but he would always listen to reasons, and if the reasons appealed to him he would abandon preconceived convictions readily and without apparent regret. He used to say that he had no "pride of invention," and would readily give up an idea on which he had long labored if convinced that something else offered was better.—*Journal of the Franklin Institute.*

Removing Splinters.—When a splinter has been driven into the hand it can be extracted by steam. Fill a wide-mouthed bottle nearly full of hot water, place the injured part over the mouth and press it slightly. The action thus produced will draw the flesh down, and in a minute or two the steam will extract the splinter, also the inflammation—*National Magazine.*

INSPECTION LOCOMOTIVE.

New York Central Lines.

The American Locomotive Company has completed at its Schenectady works an inspection locomotive for the New York Central lines. This locomotive was designed specially for this particular service, and has a very low boiler, with a high dome located over the firebox. The following list gives the chief characteristics of the locomotive, and the photograph shows its exterior appearance. With a tractive power of 14,800 lbs., this locomotive will be able to haul one or two business cars, which extends its field of usefulness beyond carrying an inspection party.

INSPECTION LOCOMOTIVE—NEW YORK CENTRAL LINES.

INSPECTION LOCOMOTIVE.

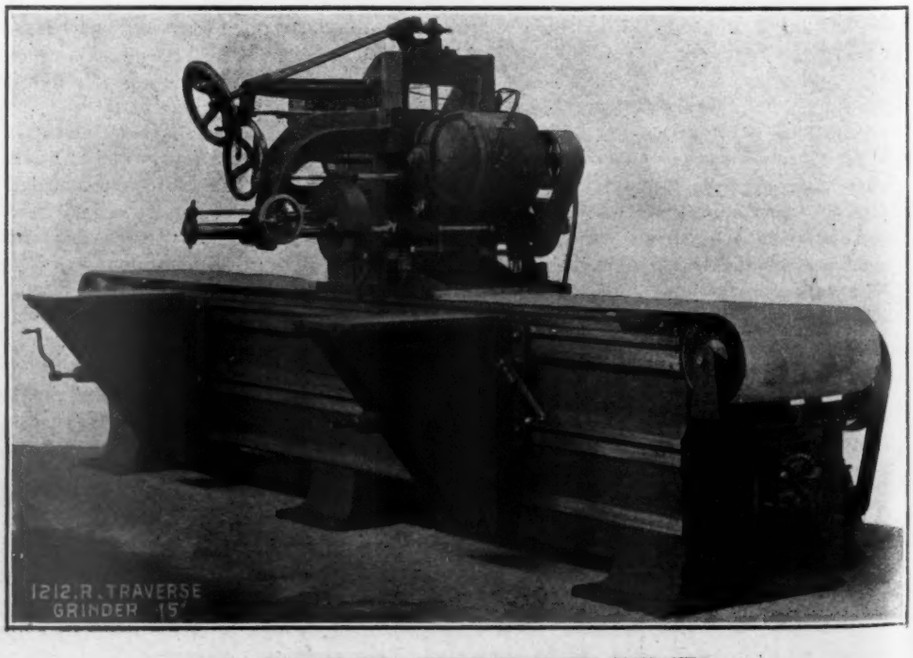
Fuel	Bituminous coal.
Tractive power	14,800 lbs.
Weight in working order	99,500 lbs.
Weight on drivers	66,500 lbs.
Weight of engine and tender in working order	182,700 lbs.
Wheel base, driving	8 ft.
Wheel base, total	22 ft. 8 ins.
Wheel base, engine and tender	46 ft. 2½ ins.
Cylinders, kind	Simple.
Cylinder diameter and stroke	15 by 24 ins.
Driving wheels, diameter over tires	62 ins.
Style of boiler	Wagon top crown bar.
Working pressure	200 lbs.
Outside diameter of first ring	46 ins.
Firebox, length and width	66 by 84 ins.
Tubes, number and outside diameter	158 2-in.
Tubes, gauge and length	11, 11 ft. 7ins.
Heating surface, tubes	951.38 sq. ft.
Heating surface, firebox	93.37 sq. ft.
Heating surface, total	1,044.75 sq. ft.
Grate area	15.72 sq. ft.
Water capacity	3,500 gals.
Coal capacity	6 tons.

An Interesting Photograph.—Mr. E. L. Lomax, general passenger and ticket agent of the Union Pacific Railroad, has issued an interesting copy of an historical photograph, showing General Grant and party at Fort Sanders, Wyo., in 1867. As is well known, during the construction of this road a great deal of trouble was encountered from attacks by the Indians, and for this reason General Grant and his party went over the road to arrange treaties with the various tribes. The photograph was taken at Fort Sanders station during this trip. The picture, besides General Grant, includes such notable men as General Grenville M. Dodge, Sidney Dillon, General Phil Sheridan, General John Gibbons, General W. T. Sherman and others. It is a picture which will be treasured by all who are fortunate enough to receive copies.

TRAVERSE GRINDER.

The illustration shows a convenient and substantial traverse grinder, which was designed specially for grinding manganese cast steel centers of railroad frogs and crossings, locomotive cross-head guides, finishing the butt ends of connecting rods, and is also adapted for such work as grinding the ways between the V's on lathe beds. The bed is cast in a box form with floor supports at the middle and the ends. It is braced internally by cross girts, and may be made in varying lengths, the one shown in the illustration being 15 ft. long, which permits a longitudinal travel of 12 ft. to the saddle which carries the grinding wheel. The saddle is traversed at the rate of 15 ft. per minute by means of a rack and pinion driven by a 2-h.p. motor, and is automatically reversed at each end of the stroke. A lever is provided for reversing the saddle by hand when necessary. The stroke may be adjusted to any length up to the limit of the machine.

The grinding wheel is driven by a 5-h.p. Triumph Electric Company motor, and has a horizontal movement in the direction of its axis of 15 ins. and a vertical movement of 11½ ins. The horizontal movement is controlled by the hand wheel attached to the bracket which supports the grinding wheel, and the vertical movement by the hand wheel on the end of the shaft, which is set at an angle. The third hand wheel is for moving the saddle by hand. The motor is adjustable on the saddle, so that when necessary the belt driving the grinding wheel shaft may be tightened.



TRAVERSE GRINDER—CINCINNATI SHAPER COMPANY.

The two tables are adjustable horizontally by means of a rack and removable ratchet wrenches, and vertically by means of screws operated by socket wrenches. Water is supplied to the grinding wheel by a pump and system of piping. The ways on top of the bed are protected from the grit by means of canvas curtains, as shown. This machine is made by the Cincinnati Shaper Company, Cincinnati, Ohio.

MANUFACTURING PLANT OF THE B. F. STURTEVANT COMPANY.

These new works at Hyde Park, Mass., will accommodate about 2,000 workmen, the aggregate floor area of the finished buildings being over nine acres. The plant consists of a four-story office building, 45 by 125 ft.; a three-story building 80 by 500 ft. devoted to the manufacture of blowers, heaters and galvanized iron work; a building 80 by 250 ft. of the same height, on the first floor of which all engines will be tested, stored and shipped, while the other floors will be utilized by the electrical department; a general machine shop measuring 120 by 500 ft., with 40 ft. side galleries devoted principally to the building of engines; a forge shop 40 by 100 ft.; a two-story building of the same floor area devoted exclusively to lockers, washing and sanitary facilities for the employees; a pattern and storage building 80 by 150 ft. in ground plan; a foundry measuring 170 by 350 ft.; a power-house 80 ft. square with detached fire and service pump-house.

MACHINE SHOP SHOWING GOOD LIGHT SECURED BY SAW-TOOTH ROOF CONSTRUCTION.

The adopted arrangement, which is slightly modified from that presented on page 359 of the November, 1902, issue of this journal, provides for a group of buildings parallel to the railroad tracks with accommodations for spur tracks between buildings, their entrance at the ends of certain buildings and an opportunity for the growth of all important structures by extension in length. The type of construction is somewhat composite in its character, consisting of steel interior columns and main steel girders, with heavy brick walls, wood-timbered floors and plank roofs. In the case of the one-story foundry, the roof is supported by steel trusses, in the other buildings open timbering with wooden columns in the upper floors is employed. The main floors in the machine, fan and erecting shops are of tar concrete, upon which 3-in. hemlock is bedded in liquid pitch and toe-nailed together. The upper floors are carried upon hard-pine beams on 4-ft. centres, spanning the spaces between the steel girders, which follow a unit system of 20 ft. on centres throughout the buildings. The machine shop gallery floors which are designed for 250 lbs. load per sq. ft., are of 2½-inch plank; other upper floors are of 2-in. plank for a load of 200 lbs. per sq. ft. Maple top flooring is used in all cases. All roofs are of 3-in. plank with tar and gravel top.

The entire plant is electrically driven and lighted at 220 volts from a central powerhouse, containing at present one 100 kw. and one 250 kw. Sturtevant generating set; the power plant engines run condensing; the exhaust steam derived from engines under test upon the plate in the testing building is utilized for heating, supplementary live steam being admitted at reduced pressure as may be required. Waste exhaust is discharged through a Sturtevant exhaust head. The boilers are equipped with a Sturtevant fuel economizer for heating the feed water. The powerhouse is placed sufficiently far from the ends of the buildings to permit of ample extension of each, and near enough to the water supply to reduce to a minimum the expense of conveying condensing and other water. Steam, electricity and compressed air are transmitted to the individual buildings through a concrete tunnel and a supplementary system of covered trenches.

The lighting of the machine shop, which is remarkably effective, is secured principally by a series of saw-tooth skylights running crosswise of the roof with glass facing due north. Tools are arranged for the progress of the work from the open end of the shop toward the finished stores and erecting shop. Machine tools are grouped by types, and so far as possible arranged for progressive operations. Space is left for additions in supplementary parallel rows. Large machines are driven by direct connected Sturtevant

GRINDING MACHINES AND STURTEVANT EXHAUST FAN, HOODS AND PIPING.

motors. Twenty horse-power motors suspended overhead are so located as to drive the small tools in groups of suitable size through individual lengths of line shaft. The smithshop is equipped with a full outfit of Sturtevant forges with blower for blast and exhaust fan for removing smoke. A detail description of the foundry and pattern shops will be found on page 431 of the November, 1903, issue of this journal.

The standard first floor height in the main buildings is 17 ft., that of the second and third stories is 15 ft. The windows are large and numerous. Ribbed glass is used in all but the lower sashes. All structural steel, window frames, racks, and bins and the walls up to a height of 5 ft. are painted a rich green. The balance of walls and ceilings is covered with white coal water paint.

The entire industrial equipment was designed and constructed by the B. F. Sturtevant Company, in the effort to secure something better than the market afforded. The outfit comprises the industrial railway system including the platform, coal, charging and dump cars, ladle trucks, truck ladles and turn-tables; the general factory equipment consisting of cast iron bench legs, electric hoists, wash-sinks, shelf-brackets for pattern storage, etc., the manhole and catch basin covers and frames, trench cover plates, hangers and the like. All of the buildings are heated and ventilated by the Sturtevant system. In the machine shop the hot air pipes are hidden beneath the second floor wall benches and deliver most of the air downward to the first floor. The fan and erecting shops are supplied through an underground duct which delivers the hot air to external vertical flues upon one side of the building, which in the case of the fan shop are located 40 ft. on centres and discharge the air across the building above head level.

CAR JOURNAL LUBRICATOR.

The Harrison car journal lubricator, illustrated herewith, is made to fit the various sizes of standard M. C. B. journal boxes and is the result of several years of experimental work. It is claimed that this is the only device that prevents the lubricant from overflowing from the box after it reaches the height of the dust guard chamber and raises the oil clear to the journal without overflowing. It is also claimed that less than 25 per cent. of the ordinary amount of oil and waste is required to pack it, and in support of this a test on the Lake

HARRISON LUBRICATOR, PACKED FOR SERVICE.

Shore & Michigan Southern Railway is cited, where a car with sealed boxes, containing 2½ pints of oil and 8 ounces of waste, ran over eight thousand miles, using less than one ounce of the lead lining of the brass. With the same amount of material, another car ran over ten thousand miles with sealed boxes.

Another important feature of these lubricators is the oil chamber in the back, which gives the bearings as perfect lubrication from the rear as from the front and overcomes the difficulty of getting oil to the rear of the journal. It will further be observed that as the lubricators hold all the lubricant and practically provide a double chamber in the back of the journal box, the packing is nearly all housed, and what sand sifts into the box falls to the bottom and is kept out of the waste. These lubricators are pressed out of one sheet of steel and resiliently mounted on malleable bases, making them practically indestructible, and after once being placed in position in the journal box need not be removed for any cause, as the box can be jacked up and the brass and wedge taken out by simply removing the waste from the lubricator as from an ordinary oil box. They are made by the Harrison-Williams Company, of Toledo, Ohio.

WHY DRIVING AXLES SHOULD BE BORED.—A couple of years ago, while the finishing cut was being taken on a steel driving axle in a lathe, the operator noticed in the freshly cut surface what appeared to be a small flaw. On testing this with a pin the pin disappeared, and quite a length of fine wire followed it. On taking out a transverse slice of the axle at this point a cavity was found in the metal, which would hold half a pint or more. The walls of the cavity were perfectly clean and bright, and but for the fact that the finishing cut just happened to open up the cavity a trifle its presence would not have been suspected, and the axle would have gone into service. It is perhaps safe to say that one-quarter, or possibly one-third, of the cross sectional area of the axle was embraced in the cavity. We have seen a number of such cases, and, unfortunately, the phenomenon is not rare. Almost any practical steel maker, when asked for the cause of such a cavity in what is apparently a solid piece of metal, would probably laconically answer, "careless heater." In order to understand this statement, it is necessary to say that many driving axles, even when they are finished, are about 11 ins. in diameter, and that the bloom from which they are forged is considerably larger. If now such a bloom when cold is put into a hot furnace, the outside layers get hot long before the inside has begun to rise much in temperature. A severe strain due to the greater expansion of the outside layers is accordingly set up, which strain is enough occasionally to actually rupture the inside. Subsequent forging opens out this rupture into a cavity. The rupture is usually accompanied by a noise like a pistol shot. The unfortunate part of the business is that, there being a number of blooms in the furnace at one time, it is impossible to tell which one has yielded to the strain. As would be expected, the larger the axle the more common this defect, and we know of one large railroad that bores a 2-in. hole through every axle over 8 ins. in diameter that is destined for passenger service. The boring of the hole enables the cavity to be discovered, either by the behavior of the drill, or by sight examinations after the hole is finished. It is interesting to know that something over 2 per cent. of all axles bored are found defective in this way.—*Dr. C. B. Dudley, before American Society for Testing Materials.*

MILLING MACHINE EFFICIENCY.—When a large variety of work has to be milled, in which cutters of greatly varying sizes have to be used, one would naturally select the machines which offer the widest range of speeds and feeds. One of the greatest advances in the construction of milling machines has been to provide them with range of speed and feed which will practically give the same peripheral speed of cutter, and proportionate rate of feed from the minimum to the maximum capacity of the machine. The wage cost of operating machines on general work of varying character will naturally increase, as it is only in the hands of a highly intelligent mechanic who thoroughly understands the details of a machine and the possibilities of milling that the best results can be secured. Given, however, a competent man, a good wage does not spell high cost of production, but is an unmistakable economy. There is no machine in the workshop which is so much influenced for better or for worse in proportion to the efficiency of its tools as the milling machine. The secret of

its failure is immediately manifest when one sees the cutters in use engaged in a tug-of-war as to whether they shall move the material or the material will remove them. This trouble often ends in a drawn game, which when summed up resolves itself into a loss of engine power, and a condemnation of the innocent milling machine. It is advisable for foremen and managers to give more attention to the purchase and maintenance of efficient cutters for milling machines, and proper toolroom facilities for keeping them in order, as apart from these points being well attended to, milling machines will simply be a delusion and a snare.—*Mr. Deakin before the Coventry (England) Engineering Society.*

BOOKS.

Railway Provident Institutions in English-Speaking Countries. By M. Riebenack, Controller Pennsylvania Railroad, Philadelphia, Pa.

This is a consolidation of reports prepared by the author for submission to the International Congress as reporter on this subject for countries using the English language, in connection with the seventh session of the Congress held at Washington, D. C., last May. This is the most complete collection of data on this subject now available, and in view of the general interest in the subject of pension systems by American railroads, it will be an invaluable aid to those who are given the responsibility of working out such systems. This admirable work covers insurance and relief systems, pension or retirement provisions, superannuation, hospital service, savings funds, co-operative schemes, libraries, literary institutes, loan provisions and welfare work. It is a record of facts of actual practice on railroads. The author's conclusions and "addenda" present some observations gained by his wide experience and exhaustive study of this vital problem of the welfare of employees. The book should have wide distribution, not only among railroad officials but among men having responsible charge of large bodies of men in any service.

Civil Engineering. A Text Book for a Short Course. By Lieut.-Col. G. J. Fiebeger, U. S. Army. 8vo, xiv. 573 pages, 180 figures. Cloth. John Wiley & Sons, 43 East 19th street, New York. $5.00 net.

The author presents in this volume a course in civil engineering, comprising those topics which are deemed essential for the West Point cadet to study, in order that he may be prepared to direct the maintenance and repair of engineering structures in times of peace, and to effect their destruction in war with thoroughness and rapidity. In consequence of this limited scope much has been omitted which a complete course in civil engineering should comprise. Railroad engineering and surveying are not considered, three chapters only are given to hydraulics and allied subects, and but one to highway engineering. The remaining twenty-three chapters are devoted to a theoretical treatment of the principles of statics, and to their application in the design of wooden, masonry, and metal structures, together with a discussion of the physical properties of these substances, and a brief article upon foundations. As a text-book for use in engineering schools giving thorough courses in civil engineering it is not well adapted. Neither would it be of much value as a reference book for the practicing civil engineer since its treatment of all subjects except structural design is far too brief to be of much service, while this subject is discussed more exhaustively and with equal clearness in a number of standard works. It should, however, prove of value to those engaged in other professions such as architecture, mechanical and electrical engineering, who may find it necessary to acquire a limited knowledge of certain civil engineering problems.

Berlin-Zossen Electric Railway Tests of 1903. A Report of the Test Runs made on the Experimental Berlin-Zossen Railway in 1903. Translated from the German by Zianz Welz, with an introduction discussing the general subject of train resistance. By Louis Bell. Published by the McGraw Publishing Company, 114 Liberty street, New York, 1905. Price, $3.00.

This book of seventy-four pages of text, with eighteen illustrations and thirty-eight full page diagrams, presents official information concerning the high speed experiments upon the special track between Berlin and Zossen for the development of fundamental data on the subject of high speed travel. This record is unique in that it affords the first accurate knowledge of train and car resistance at speeds of 100 miles per hour and upwards. The experiments themselves develop the possibility and feasibility of transmitting power in large quantities to a car moving at extremely high speeds. The experiments also develop valuable information concerning the behavior of cars and road beds at these speeds and shows the limitation of even specially good construction of track. While the record at hand does not cover complete trials it presents the results of the most important tests which were made in the latter part of the year 1903, placing them at the disposal of those who are familiar only with the English language. The work of the translator is commendably complete and is extended to all of the data and to the diagrams of results. The work includes comments upon the commercial practicability of high speeds and includes a discussion of cost, fares and passenger earnings. Specially valuable information is included concerning air and train resistance, the power required for acceleration and a large number of drawings, showing the details of construction and attachment of the motors. This is an exceedingly valuable document, which will be appreciated by all students of high speed transportation.

PERSONALS.

Mr. F. L. Hunter has been appointed purchasing agent of the El Paso & Southwestern Railway.

Mr. Hugh Craig has been appointed general car inspector of the Western lines of the Canadian Pacific, with headquarters at Winnipeg, Man.

Mr. J. H. Eaton has been appointed assistant master car builder of the Western lines of the Canadian Pacific Railway, with headquarters at Winnipeg, Man.

Mr. A. S. Grant has been appointed master mechanic of the Missouri division of the Missouri Pacific Railway at De Soto, Mo., to succeed Mr. W. J. Haynen, resigned.

Mr. H. W. Jacobs has been appointed engineer of shop methods and tools of the Atchison, Topeka and Santa Fe Railway, with headquarters at Topeka, Kansas.

Mr. W. J. Haynen has been appointed superintendent of motive power of the Detroit, Toledo & Ironton at Springfield, Ohio. He was formerly master mechanic of the Missouri Pacific at De Soto, Mo.

Mr. Carl A. Strom of Chicago, who resigned the position of mechanical engineer of the Illnois Central R. R. in May, 1904, to become mechanical engineer of the Isthmian Canal Commission, at Panama, has recently been promoted to the position of superintendent of motive power and machinery of the Panama Canal.

Mr. M. E. Wells has been appointed traveling master mechanic of the Wheeling & Lake Erie, the Wabash Pittsburgh Terminal and the West Side Belt Railroads. He will have supervision over roundhouse service, the care of locomotive boilers on the road and at terminals, and the character of the locomotive water supply.

Just before going to press word was received of the sudden death under exceptionally sad circumstances of Mr. W. P. Appleyard, superintendent of equipment of the Pullman Company. Mr. Appleyard was 49 years of age and one of the best and most favorably known authorities on car building of the time. His unusual ability was combined with a remarkable personality. His quiet dignity uprightness of character and frank friendliness brought admiration from all who knew him. He was educated in engineering and architecture. In 1888 he entered the service of the Pullman Company as mechanical inspector, and was promoted to the position of superintendent of repairs. In 1893 he became master and builder of the New York, New Haven & Hartford Railroad. He returned to the Pullman Company as superintendent of equipment in Februarv of last year. His death brings sadness and keen sense of personal loss to hosts of friends and associates.

CATALOGS.

WRENCHES.—A catalog of the drop forged machine wrenches made by the Billings & Spencer Company, Hartford, Conn.

PNEUMATIC TOOLS.—Catalog F from the Cleveland Pneumatic Tool Company of Cleveland, Ohio, is devoted entirely to their pneumatic hammers and drills.

AIR COMPRESSORS.—Bulletin L-508 received from the Laidlaw-Dunn-Gordon Company, Cincinnati, Ohio, gives a complete, illustrated, detailed description of the improved Cincinnati air compressors.

ELECTRIC MOTORS.—Bulletin No. 261 from the Triumph Electric Company, Cincinnati, Ohio, describes their new steel frame multipolar motors, a description of which appears on another page of this issue.

REAMERS AND CORE DRILLS.—A revised price list from the Three Rivers Tool Company, Three Rivers, Mich., of the Matthews high speed core drills and reamers. These tools have blades of high speed steel brazed into soft steel bodies.

MOTORS AND GENERATORS.—Bulletin No. 51 issued by the Northern Electrical Manufacturing Company, Madison, Wis., is devoted to a detail description of their generators and motors with "ring" type fields. These are for large ratings, and if desired may be equipped for variable speed.

CRANE VALVES.—The Crane Company of Chicago have issued a four-page circular illustrating their renewable spring disc brass valves made in globe, angular and cross forms, suitable for working pressure up to 150 lbs. The circular illustrates and describes the valves and discs and presents sizes and prices of all the varieties furnished.

ENGINES AND DYNAMOS.—Bulletin No. 16 issued by the Ridgway Dynamo & Engine Company, Ridgway, Pa., gives the names of a large number of customers who have from one to twenty McEwen engines and Thompson-Ryan dynamos in daily operation, and who will be glad to answer questions of prospective purchasers concerning these machines.

ELECTRIC TRAVELING HOISTS AND TROLLEYS.—The Niles-Bement-Pond Company, 111 Broadway, New York, have issued a very interesting catalog of their electric hoists and trolleys, and have devoted considerable space to an application at the Ramapo Iron Works, Niagara Falls, N. Y. The system described could be used to advantage for handling material in railway store-houses and scrap yards and a description of it will be found on another page of this issue.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.—The American Locomotive Company are issuing an attractive publication which describes in detail the large Mallet compound built for the Baltimore & Ohio Railroad, and considers the advantages of this type of construction and compounding. It also contains a number of interesting comments from the technical press on the design and working of the B. & O. engine, which is the largest and most powerful locomotive ever built.

PIPE JOINTS.—Advance circulars have been received from the Crane Company, Chicago, Ill., describing their Cranelap extra heavy flanged pipe joints with flanges made from cast iron, ferro-steel, malleable iron, cast steel or weldless steel, suitable for working pressures up to 250 lbs.; also their Craneweld flanged pipe joints with wrought steel flanges welded on, suitable for pressures up to 250 lbs. The latter circular also illustrates the different operations on and methods of facing extra heavy companion flanges suitable for working pressures up to 250 lbs.

BALDWIN LOCOMOTIVE WORKS.—Nos. 51 and 52 of the "Record of Recent Construction" of the Baldwin Locomotive Works have been received. The former illustrates a number of locomotives built for various classes of service, beginning with the four-cylinder balanced compound for the New York Central and Hudson River Railroad, this being the 25,000th locomotive produced by these works. The latter publication presents the subject of solid forged and rolled steel wheels as manufactured by the Standard Steel Works at Burnham, Pa. It illustrates the works, the process of manufacture, discusses the merits of steel wheels for passenger and freight service, presents physical tests and chemical analysis and includes a number of designs of standard steel wheels for various classes of service.

NOTES.

HOLLOW STAYBOLTS.—The Hollow Staybolt Company, Cuyahoga Falls, Ohio, have orders for hollow staybolt iron bars for export to a leading railroad of Japan and for the Imperial Railway of North China.

ELECTRICAL CONTROLLER & SUPPLY COMPANY.—Mr. H. F. Stratton. who has been connected with the main office at Cleveland, Ohio, has accepted the position of New York representative, with offices at 136 Liberty street, New York City.

OIL AND GAS ENGINE PATENTS.—A digest of United States patents of air, caloric gas and oil engines, including the years from 1789 to July, 1905, has been prepared by Mr. James T. Allen, examiner United States Patent Office, Washington, D. C., which is soon to be published. It contains 2,000 pages in three volumes with claims and briefs, including references and decisions.

RESORTS AND TOURS.—This is a vacation directory and encyclopaedia for the traveler. It contains 90 pages of delightful descriptive reading, excellent half tones and a list of about 1,500 resorts, including rates, hotels and railroad routes. It is mailed free on application by postal card, to Mr. D. J. Flanders, general passenger and ticket agent, Boston & Maine Railroad, Boston, Mass.

STURTEVANT ROUNDHOUSE HEATING.—Three of the new roundhouses of the Erie Railroad are to be equipped by the B. F. Sturtevant Company, of Boston, Mass., with complete systems of heating and ventilation, particularly applied for thawing out engines during the winter. These include a 10-stall house at Marion, Ohio, a 14-stall house at Kent, Ohio, and a 10-stall house at Hammond, Ind.

AMERICAN LOCOMOTIVE COMPANY'S EARNINGS.—The fourth annual report of the president of the American Locomotive Company shows that in the year ending June 30th the gross earnings were $24,150,201.06, a decrease of $8,918,549.50 from the earnings of the previous year. The expenses were $19,796,533.49, a decrease of $7,608,451.91, leaving a net earnings of $4,353,667, which is $1,310,097 less than the previous year. After providing for interest and dividends and for permanent investments a surplus of $607,924.26 is carried to the credit of profit and loss account.

LOCOMOTIVE APPLIANCE COMPANY.—At the meeting of the board of directors of the Locomotive Appliance Company August 21st, the election of officers and an executive committee, for the ensuing year, resulted as follows: Mr. Ira C. Hubbell, president; Mr. Willis C. Squire, vice-president; Mr. Clarence H. Howard, vice-president; Mr. J. J. McCarthy, vice-president; Mr. J. B. Allfree, consulting engineer; Mr. E. B. Lathrop, treasurer; Mr. W. H. England, secretary. And the president, Mr. Willis C. Squire and Mr. E. B. Lathrop were elected the executive committee.

A LARGE HEATING PROBLEM.—The magnitude of the heating proposition in a large railroad shop is well exemplified in the case of the new shops of the Southern Railway Company, at Spencer, N.C. The machine shop alone contains 4,500,000 cu. ft., and requires for its heating two special steel plate fans, 9½ ft. in diameter, driven by 10 x 10 horizontal engines and installed in connection with a total of about 21,000 ft. of 1-in. pipe massed in individual heaters. The entire equipment was furnished by the B. F. Sturtevant Company, of Boston, Mass., and is designed to maintain a temperature of 60 deg. when the outdoor temperature is 10 deg. F. Distribution is made through a system of overhead piping with discharge pipes leading down to within about 10 ft. of the floor.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, returned on September 8 from Europe where the past six weeks were spent in the interest of the foreign business. While abroad the Fraserburgh and Berlin factories were started up and manufacturing arrangements were perfected in Russia. All factories are now running in good shape with sufficient business to keep them constantly occupied for several months, and the outlook generally is the most satisfactory of any period in the history of the company. Domestic inquiries are extremely heavy for all classes of tools and appliances. One hundred and fifty-seven Franklin compressors have been sold during the past ninety days.